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Project, Whittier, CA

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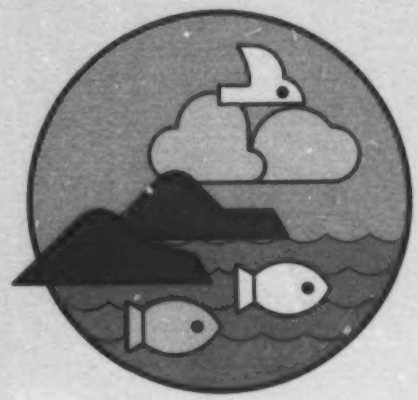

LA/OMA PROJECT

SLUDGE MANAGEMENT ALTERNATIVES

FOR THE
LOS ANGELES / ORANGE COUNTY
METROPOLITAN AREA

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LA/OMA PROJECT - the regional wastewater solids management program for the Los Angeles-Orange County Metropolitan Area

Participating Agencies:

-U.S. Environmental Protection Agency (Region IX)

-California State Water Resources Control Board

-City of Los Angeles

-County Sanitation Districts of Los Angeles County

-County Sanitation Districts of Orange County

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Results of analysis of candidate systems for sludge management are summarized. Least attractive candidate systems are identified and deferred from further study. Fundamental sludge management alternatives are described and changes in the LA/OMA Project workplan are defined.

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PREFACE

National concern for environmental protection and resource recovery has resulted in a wide range of legislation which affects wastewater treatment and disposition of residuals. The implementation of this legislation has necessitated the development of innovated programs. This report describes the efforts being undertaken in the Los Angeles-Orange County Metropolitan Area to deal with that portion of such legislation which affects the processing and use or disposition of wastewater solids (sludge).

The report describes sludge management planning in the Los Angeles-Orange County Metropolitan Area, summarizes the results of preliminary studies which explored various systems of sludge processing, and describes sludge management alternatives which are proposed for further study.

This report is intended to be a study document. During the months of May, June, and July of 1977, it will be discussed and debated at community workshops and through other public media. At the conclusion of review, public comments will be evaluated and a work program for the remainder of the LA/OMA Project will be adopted.

Inquiries about the Project and comments upon the contents of this report should be made to:

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LA/OMA PROJECT

SLUDGE MANAGEMENT ALTERNATIVES FOR
THE LOS ANGELES - ORANGE COUNTY METROPOLITAN AREA

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CHAPTER ONE

SLUDGE MANAGEMENT PLANNING IN THE LOS ANGELES ORANGE COUNTY METROPOLITAN AREA

Sludge management in the Los Angeles Orange County Metropolitan Area is principally the responsibility of the three major wastewater treatment agencies operating in the area--

-City of Los Angeles
-Los Angeles County Sanitation Districts
-Orange County Sanitation Districts

In 1976, these agencies collectively received about 900 dry tons per day of sludge for processing and disposal. By the year 2000 the volume of sludge is expected to double, principally as a result of implementation of secondary treatment. The major portion of this increase (about 80%) is expected to occur by the late 1980's. Additional factors which magnify the resulting problem of sludge management are the need to comply with State and Federal prohibitions of sludge discharge to the ocean, restrictions imposed by other regulatory agencies, and the uncertainty associated with the substantially different character of the sludge that will be produced by secondary treatment.

LA/OMA PROJECT BACKGROUND

The need for a regional approach to the sludge management problem was recognized in 1973 with the initiation of discussions among the local agencies and the State and Federal governments. In October 1974 a Joint Powers Agreement was executed which created the LA/OMA Project and established a five member Policy Board to guide and direct the Project. Current Policy Board members are---

Allan S. Abramson . . . Environmental Protection Agency
Bill B. Dendy . . . . . State Water Resources Control Board
Fred A. Harper. . . . . Orange County Sanitation Districts
John D. Parkhurst . . . L. A. County Sanitation Districts
Donald C. Tillman . . . City of Los Angeles

The Joint Powers Agreement provided that a Project Manager be retained and provided with overall responsibility for conduct of the work. The Project employs a total of ten persons. In addition to the Project Manager, three persons are engineers, two are assigned to public participation, one person is an environmental scientist and the remainder are support personnel.

Funding and Work Program

Funds for the LA/OMA Project are obtained under the Clean Water Grant Program. The total project cost of $3.4 million is shared-- 75% by the Environmental Protection Agency; 12.5% by the State Water Resources Control Board; and 12.5% by the three wastewater treatment agencies on an equal share basis.

The goal of the Project is to develop, by December 1978, a long-term sludge management plan and implementation strategy. The plan is to provide for reuse and disposal of the residual solids resulting from municipal and industrial wastewater treatment in an evironmentally, economically, and socially acceptable manner.

The Phase I Report published by the Project in August 1976 describes the Project work program and defines 17 systems for processing and disposition of sludge. These 17 systems represent the candidate alternatives which were considered to be deserving of examination prior to formulation of the sludge management alternatives which would receive detailed evaluation. The work program consists of the following four basic components--

* Demonstration projects to develop operational experience and design information. These demonstration projects are being conducted by the local participating agencies with funding from LA/OMA Project.

* Formulation of sludge management alternatives through screening of candidate systems by evaluation of the technical, economic, environmental and social factors associated with each candidate system.

* An active ongoing public participation program to seek and develop public awareness, comment, and recommendations.

* A planning process to consolidate results from the other program components and provide for: evaluation of sludge management alternatives, formulation of a sludge management plan and implementation strategy, and preparation of the environmental impact statement and project report.

The discharge of sludge to the ocean is of major interest to the agencies participating in LA/OMA Project. Although Clean Water Grant funds are available for use in assessing the effects of existing sludge disposal practices for the "no project" alternative as required by the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA), EPA and the State Water Resources Control Board have stated that Clean Water Grant funds may not be used to study alternative means for ocean disposal of sludge since such alternatives are

precluded by state and federal regulation. In order to provide examination of ocean discharge, the three local participating agencies have agreed to provide 100% local funding (in the amount of $75,000) for studies of ocean disposal alternatives conducted under the LA/OMA Project.

The LA/OMA Project has been underway on a full scale basis since the first part of 1975. During the first year of full time effort, work centered around the recruitment of staff, project organization, indentification of candidate systems, preparation of a state of the art survey report on sludge processing and disposal, formulation of the Project work plan, and publication of the Phase I Report. The Project has now moved into active development of the sludge management plan and conduct of studies.

Demonstration Projects

Demonstration projects were recognized early in the project as an important factor in developing a sludge management plan. For example, it was recognized that additional information would be required to adequately evaluate the factors associated with the use of sludge in agriculture. Accordingly in early 1976, a demonstration project was designed and undertaken in cooperation with the University of California at Riverside to develop guidelines and criteria for use of sludges on cropland.

Major demonstration projects which are underway or planned are--

Project Name Start Date	Project Description and Estimated Cost
Pyrolytic process (March 1976)	A pilot program to obtain data and experience for a full scale pyrolytic process($30,000).
Thermal Pretreatment (August 1976)	A pilot scale evaluation of the effect of thermal treatment prior to digestion on gas production and sludge dewaterability($85,000).
Carver Greenfield (May 1977)	A pilot scale evaluation of the use of the mutiple effect evaporation process in sludge treatment($100,000).
Deep Pile Composting (March 1977)	A field demostration of the feasibility of composting sludge in deep piles ($66,000).
Evaporation Project (January 1977)	A pilot scale program to obtain data on operational characteristics of evaporation ponds used for sludge dewatering($66,000).
Toxicant Removal (June 1977)	A laboratory scale study to examine the practicality of toxicant removal through treatment of sludge($15,000).

Project Name Start Date	Project Description and Estimated Cost
Mechanical Dewatering (March 1977)	Field demonstrations of various mechanical dewatering devices($30,000).
Pathogen Survival (June 1976)	A series of laboratory examinations to determine the degree of pathogen survival during demonstration projects ($40,000).
Landfill Demonstration (May 1977)	A bench scale evaluation of leachate production from sludge-refuse mixtures ($20,000).
Ag. Applications-UCR (October 1975)	A full scale field study to determine soil and crop responses to sludge, and to develop guidelines and criteria for use of sludge in agriculture($253,000).

Candidate System Analysis

Early in 1976, known processes for treatment, transportation, disposal and reuse of sludge were examined by Project staff and staff of the participating agencies. In addition, public input was solicited through the distribution of Project brochures, newsletters, press releases, and public presentations, including a public hearing held in May, 1976. This initial evaluation resulted in the identification of seventeen candidate systems which merited evaluation prior to formulation of sludge management alternatives for detailed analysis.

In August 1976, CH2M Hill Engineers under contract to LA/OMA Project initiated the evaluation of the 17 candidate systems to provide information and a basis for formulation of sludge management alternatives. This work, which has just been completed, included the development of detailed cost and energy information, preliminary identification of environmental concerns, and recommendations regarding systems which should be studied further.

The CH2M-Hill work is contained in their report "Initial Analysis of Candidate Systems and Preliminary Site Identification".

Chapter two of this document briefly describes each of the candidate systems and summarizes the comparative analysis done by CH2M-Hill. Some of the major findings from the consultants work are:

* Energy will be a major factor in the evaluation of sludge management alternatives since high energy consumption increases economic cost while energy recovery through digestion reduces economic cost due to availability of existing digester capacity and the value of the fuel produced through digestion of the sewage solids.

* Mechanical dewatering incurs very large operating and maintenance expenses and energy requirements which could probably be avoided if a suitable location could be found for use of solar evaporation.

* Transporation of large quantities of liquid sludge is most economical using barge or pipeline facilities.

* Compost drying appears as a component of the more attractive systems, however increasing sludge volumes will require more land if the windrow method of composting is practiced.

* Sanitary landfills will play an important role in sludge management because of the apparent availability of Class II landfill capacity.

* Digested dewatered sludge from the three wastewater treatment agencies is equal to about 2 percent of the total volume of solid waste generated in the Los Angeles Orange County Metropolitan Area.

* Moisture content of sludge is a major factor affecting placement of sludge in Class II sanitary landfills. If excessive moisture is present, State regulatory constraints will most likely necessitate use of Class I landfills for sludge disposal.

* Dry lake basins in the desert should receive further investigation as potential areas to reveive sludge.

* Low rate application of sludge for agricultural use (balance sludge application to meet crop needs) appears to be feasible in Ventura County, Southern San Joaquin Valley, Antelope Valley, S.W. San Bernardino County, Western Riverside County, Coachella Valley, Orange County, and Imperial Valley.

* Only the San Joaquin and Imperial Valleys have sufficient capacity to use all of the sludge from the Los Angeles Orange County Metropolitan Area under the low rate agricultural application mode.

* Potential for low rate agricultural reuse in Ventura County, Southwestern San Bernardino County, Western Riverside County, and Orange County is expected to decline in the future as urban expansion removes farmland from production.

* High rate agricultural application(maximize sludge application-crop production a secondary consideration) would require significant amount of land. Areas most feasible for high rate agricultural reuse are

the Southern San Joaquin Valley and (if water is available) the Antelope Valley.

* The acceptability of agricultural use will depend upon local acceptance of the practice and has yet to be determined.

* Land reclamation does not appear to hold great promise except perhaps on existing military reservations.

* Urban use of composted sludge, currently practiced in the Los Angeles Orange County Metropolitan Area, is expected to continue to reuse a substantial amount of sludge, barring issuance of highly restrictive regulations. However, it is not probable that the total volume of sludge can be recycled in this manner.

* Exportation of liquid digested sludge to foreign countries may be possible, however definitive cost or reliability information are unavailable to assess the prospect. Since exportation is susceptible to actions not within the control of the LA/OMA agencies, it may not be an ultimate solution to the problem.

* Final State regulations governing the use and disposal of sludge will impact the extent of any reuse in all areas--agricultural as well as urban.

Staff Studies

Several studies are designed to be conducted by Project staff. These studies which generally are directed at the development of background information which will be used in evaluation of the sludge management alternatives are--

Hydrofracturing Assessment	An assessment of the practicality for subsurface injection of sewage sludge.
Landfill Literature Review	Review of information on the effects of addition of sewage sludge to sanitary landfills.
Sludge Characteristics	Determination of the existing and projected characteristics of sewage sludges generated by the LA/OMA agencies.
Source Control Impacts	Projection of the impact of source control requirements on municipal sludge character
Ocean Disposal Alternatives	Assessment of the engineering aspects of alternative ocean disposal practices.

Of the foregoing, studies of sludge characteristics, source control impacts, and ocean disposal alternatives are underway. The results of staff studies will be reported in Project Technical Reports.

Consultant Studies

Gruen Gruen + Associates has been retained to provide marketing research services to the Project. The prospect for large scale reuse of sludge is expected to depend heavily upon a good definition of the reliablity of the markets for use and a well defined program to meet demands. Gruen Gruen + Associates, who started work in mid-April, will emphasize the identification of potential uses and the development of strategies for marketing sludge products.

Studies of the effects of existing sludge disposal practices upon the marine environment will soon be undertaken by the Southern California Coastal Water Research Project. These studies will provide information for use in evaluation of the "no project" alternative as required by state and federal environmental legislation.

Consultants will be selected during May to assist in the evaluation of ocean disposal alternatives. These studies will address the engineering feasibility of deep ocean outfalls and develop information on deep ocean basins which lie offshore of the Southern California coast. These studies as well as staff studies of ocean disposal alternatives as supported entirely by the local agencies.

Nonsewerable Waste Studies

Implementation of pretreatment requirements and diminishing availability of Class I landfill sites have caused concern regarding the availablity of a proper management plan for the nonsewerable residuals, other than solid waste, which will be generated.

Studies of the problem are about to begin. The local participating agencies, with funding from LA/OMA Project, are undertaking work to characterize and quantify the nonsewerable wastes generated within their respective jurisdictions and to project the impact of source control requirements upon the generation of such waste. The results of this work will provide the basis for design of appropriate demonstration projects for processing and disposal of such waste. See Chapter Four full a full discussion of this item.

SLUDGE MANAGEMENT ALTERNATIVES

The analysis of candidate systems and the inventory of possible sites to receive sludge has provided information on economic costs, energy production and consumption, air quality impacts,

and required land acquisitions. Using this information and the results of ongoing work, LA/OMA Project has formulated six sludge management alternatives which will receive detailed evaluation during the preparation of a Project Report and Environmental Impact Statement. Those alternatives are described in Chapter Three of this document and are highlighted below:

Sludge Management Alternative #1 - Long Distance Transport

Management Alternative 1 provides for long-distance transport of liquid sludge to sites outside the urban area for solar drying or direct agricultural use. A dried or composted sludge product may be marketed or reused in urban or agricultural applications. Solar energy is used for dewatering to reduce energy consumption and avoid complicated and costly dewatering machinery.

Sludge Management Alternative #2 - Composting-Sludge Recycle Center

Management Alternative 2 involves the composting of sludge in the urban area and emphasizes and reusing it in urban or agricultural markets. The dewatered and composted sludge product may be marketed as a soil conditioner. Landfill provides a backup system for the ultimate disposal of dewatered sludge.

Sludge Management Alternative #3 - Thermal Processing

Management Alternative 3 combines major elements from three thermal processes. The volume of sludge is significantly reduced providing for more practical land disposal methods. Char produced during pyrolysis may be reused with the treatment plant as activated carbon. The dried sludge produced is a safe and reliable material from a health standpoint.

Sludge Management Alternative #4 - Ocean Disposal

Management Alternative 4 provides for ocean discharge of sludge by ocean outfall into deep waters or by barge transport with dispersal over large areas. The alternative is reliable and flexible and has negligible land use impacts. Cost, energy, and air emission factors are favorable.

Sludge Management Alternative #5 - Separate Secondary Sludge Processing

Management Alternative 5 recognizes the unique characteristics of waste-activated sludge (WAS) including its high nitrogen content (5% - 8%) and difficult dewatering. WAS has a potential marketing value as fertilizer if health constraints can be accommodated. Treatment of WAS separate from primary sludge allows improved dewatering results of the latter.

Sludge Management Alternative #6 - Baseline - "No Project" Alternative

Management Alternative 6 is the "no project" concept - separate sludge disposition for each LA/OMA participating agency - required by both NEPA and CEQA. This alternative is a combination of land and ocean disposal processes. It serves as a baseline from which impacts of other alternatives can be measured. "No project" would result if no action were taken to solve the sludge disposition issue at the conclusion of the LA/OMA Project.

FUTURE ACTIVITIES

Public Participation

Workshops are scheduled to be held in May and June of 1977 in each of the areas affected by the findings contained in this report. The primary intent of these meetings is to provide the public the opportunity to become familiar with the Project, to give input, and to establish a basis for continuing dialogue. Specific points to be addressed in the public workshops include:

- comment upon the results and conclusions gleaned from the analysis of the candidate systems (see Chapter Two);
- comment upon the sludge management alternatives which are described in Chapter Three; and
- comment upon the revised work schedule and overall work program of the LA/OMA Project (see Chapter Four).

It is hoped that input received through the workshop process will assist in refining the sludge management alternatives and in directing future efforts of the LA/OMA Project. At the conclusion of this initial workshop sequence, a revised work program and budget will be presented to the LA/OMA Project Policy Board for approval.

Additional public participation and outreach programs will be included in the overall Project work program.

Program Direction

The completion of the analysis of the candidate systems and definition of the sludge management alternatives signals a change in the direction of the LA/OMA Project. Whereas, previous work focused upon the elimination of candidate systems through the alternative screening process, LA/OMA Project will now begin to focus upon actual plan development. Plan development refers to the combining of the EIS/EIR process, workshops, and various studies to create programs for each of the sludge management alternatives. This work will lay the basis for the creation of the Step One - Project Report and Facilities Plan.

In the interim period between public review and response to this document and the adoption of the detailed work plan for the remainder of the LA/OMA Project, staff will continue the various demonstration projects which are underway and enter into contracts for remaining work which must be carried out regardless of what direction the final work program takes.

CHAPTER 2

CANDIDATE SYSTEM ANALYSIS

In the LA/OMA Project Phase I Report, seventeen approaches for processing and disposal of sludge were described. These concepts were termed "candidate systems" and each represented a concept of processing or disposal unique from the other candidate systems. The number of systems was later increased to eighteen to allow consideration of a "no-project" alternative required to meet state and federal guidelines.

In order to determine preliminary costs, energy consumption factors, environmental and social concerns, implementation capability, process reliability and flexibility, public health impacts, and land use requirements for the eighteen candidate systems, a consultant contract was awarded to the firm of CH_2M-Hill. Included in the contract was research regarding an inventory of existing and potential sites for sludge disposition.

The purpose of this Chapter is to present the major conclusions resulting from the CH_2M-Hill work and other related LA/OMA studies. This is done by:

- -presentation of a brief description of each candidate system,
- -a comparison of the systems, and
- -identification of the least attractive candidate systems.

This information serves as a background for the development of the sludge management alternatives presented in Chapter Three. More detailed information on each of the candidate systems and their analysis can be found in reference documents identified in Appendix B.

It is emphasized that, in this phase of analysis, environmental, social, and political concerns have been addressed only on a preliminary basis. A comprehensive analysis of these factors will be developed as part of the EIR/EIS process which accompanies the remaining phases of the Project work plan.

DESCRIPTION OF THE CANDIDATE SYSTEMS

From the essentially infinite number of theoretical process and ultimate disposal possibilities, 18 candidate systems were identified for preliminary analysis. Each system was designed to recover, reclaim, or recycle at least one of the potential resources contained in sewage sludge, whether it be energy, nutrients, humus, or others. In addition, each system was considered to be technically feasible, compatible with existing treatment facilities, reasonably cost-effective, and devoid of excessive adverse environmental effects. A brief description of each candidate system, extracted from the LA/OMA Project Phase I Report, follows:

Candidate System 1 (Incineration)

Combustion offers the advantages of volume reduction, pathogen and chlorinated hydrocarbon destruction, and possible energy recovery. However, air pollution emissions, overall energy needs, and capital/operation/maintenance costs are areas of concern.

Waste activated sludge (WAS) from the secondary treatment aeration tanks would be thickened to concentrate the solids. The thickened WAS would then be blended with raw primary treatment sludge. The combination may or may not be subjected to anaerobic digestion prior to dewatering; however, the combination would be subjected to conditioning. Thermal or chemical conditioning would permit the sludge to be more easily dewatered. The liquid sidestream from the dewatering process would be recycled to the treatment plant influent. Following concentration of solids by dewatering, the sludge would be converted to inert products (ash) by incineration.

Energy in the form of waste heat, might be recovered, particularly if municipal refuse is added to the sludge during combustion. Possibilities for using the waste heat include digester heating, steam and electrical production, and operation of thermal conditioning equipment. Inert products would probably be landfilled, although some agricultural or land uses may be possible. This system was evaluated under several sets of constraints or standards, including the applicable official air quality emission requirements for the South Coast air basin. Sufficient emission control equipment would have to be installed on any recommended system to meet officially mandated air pollution control requirements.

Candidate System 2 (Pyrolysis)

The operations associated with this system are similar to those for Candidate System 1, except incineration is replaced by a process called pyrolysis. Pyrolysis reduces the volume of sludge by a thermal decomposition process and also sterilizes the end product. It offers the potential advantage of producing and capturing useful by-products, such as oil, fuel gases similar to natural gas, tars, and fuel bases, with the potential for little or no air pollution. Once again, emissions, energy needs, and costs are critical considerations.

Candidate System 3 (Separate WAS Treatment)

Raw primary sludge would be treated as in Candidate System 1 or 2. However, WAS would be treated separately to take advantage of energy or waste heat recovered from primary sludge treatment. The WAS would be initially processed as in Candidate System 1 or 2: thickening, anaerobic digestion (optional), thermal or chemical conditioning and dewatering. It would then be either heat or compost dried.

Energy would be recovered from primary sludge treatment in the form of waste heat from combustion or fuel products from pyrolysis. This energy could be used for thermal conditioning or heat drying

of the WAS. The dried WAS would contain a relatively high nitrogen content and might be used for agricultural applications rather than being landfilled.

Candidate System 4 (Co-pyrolysis with Refuse)

Sludge processing would be essentially the same as Candidate System 2, up to the point of pyrolysis. At that point, dewatered (or possibly compost dried) material would be trucked to a municipal refuse facility and co-pyrolized with refuse. The advantage is that little additional capacity at the refuse pyrolysis facility would be required to handle the dewatered sludge. Inert products (ash) would probably be landfilled, although some agricultural or land uses may be possible.

The use of liquid digested sludge at the pyrolysis facility is also a possibility. Although it would decrease the thermal efficiency of the pyrolysis reactor, it would save the energy and costs necessary for dewatering. However, the availability of a municipal refuse pyrolysis facility and associated sludge transportation costs are important considerations.

Candidate System 5 (Active Char Production)

The Jet Propulsion Laboratory (JPL) has developed a physical-chemical process for the treatment of wastewater. Pyrolysis is used to convert dewatered raw sludge to activated carbon. The carbon is then used to treat the raw sewage by removing dissolved and suspended organics by adsorption. This process is being actively investigated by the Orange County Sanitation Districts. Its implementability, overall energy needs, and capital/operation/maintenance costs are currently being examined.

Candidate System 6 (B.E.S.T. Dehydration Process)

The Basic Extractive Sludge Treatment (B.E.S.T.) process is used for sludge dewatering and dehydration. Sludge solids are separated from the water by a solvent extraction technique. Then the sludge is dehydrated to less than ten percent moisture content.

The dry solids should be suitable for landfilling, land application, or self-sustained combustion or pyrolysis. Liquid sidestreams from the process may require separate treatment. The potential advantage of this system is that the solvent can be evaporated with less energy input than that required to evaporate water. However, its reliability, flexibility, and associated processing costs are important considerations.

Candidate System 7 (Carver-Greenfield Multiple-Effect Evaporation Process)

In the Carver-Greenfield system, water is extracted from sludge by using a multiple-effect evaporator. The incoming sludge is mixed

with an oil to maintain fluidity during processing and to minimize scaling or corrosion of equipment. Multiple-effect evaporation is economical in the sense that heat is reused in each subsequent effect. Through such reuse, the amount of water removed per pound of steam supplied increases with increased number of effects. Liquid sidestreams can be recycled to the plant influent.

The dry sludge product from the Carver-Greenfield process would be suitable for landfilling, land application, or self-sustaining combustion or pyrolysis. The concerns of Candidate System 6 are also common to this system.

Candidate System 8 (Dewatering for Landfill or Agriculture)

Sludge processing would consist of anaerobic digestion (with methane gas recovery), conditioning and dewatering. Following dewatering, several land use options would be available, depending on the ultimate disposition of the sludge. Dewatered sludge could be: (1) trucked to a landfill; (2) compost dried and trucked to a landfill; (3) trucked to a landfill, compost dried, and buried; or (4) compost dried and hauled by rail or other means to an agricultural use site. Land use, transportation costs, groundwater impacts, and potential public health effects are areas of concern.

Candidate System 9 (Sludge Recycle Center)

Sludge processing would consist of anaerobic digestion (with methane gas recovery), conditioning, and dewatering. Following dewatering, sludge would be heat or compost dried. The dried material would then be transported to a regional "sludge recycle center", which would be established to market the product and provide temporary storage facilities. Dried sludge which could not be marketed would be landfilled. The operating agencies would supply dried sludge as a resource product, at a reasonable price, for commercial and business enterprises. Market viability and potential public health effects are important considerations.

Candidate System 10 (Evaporation Ponds)

WAS would be thickened and blended with raw primary sludge. The combination would then be anaerobically digested to recover methane gas. Following digestion, the stabilized sludge would be transported via pipeline to storage and evaporation ponds in high-rate evaporation regions of Southern California.

The basic advantage of the evaporation pond concept is that solar energy is used to dewater the solids and no liquid sidestreams are produced. However, energy must still be utilized to pump the liquid digested sludge up and out of densely populated areas to more open areas. Alternatives for final disposal of the residual solids remaining after evaporation include: (1) landfilling at a site near the evaporation ponds; (2) landfilling at an existing landfill which may be some distance from the evaporation pond; and (3) marketing of the produce for agricultural use. Land use, transportation costs, overall energy needs, groundwater impacts, and potential public health effects are important considerations.

Candidate System 11 (Remote Dewatering for Landfill or Agriculture)

Candidate System 11 is a variation of Candidate System 8. The basic difference is that pipeline transport is used to convey liquid digested sludge to a central location for subsequent mechanical processing and disposal. Liquid sidestream treatment and site selection woudl be critical factors in such a system. The advantage of such a system is that economies of scale may be realized by providing centralized processing facilities. However, the concerns of Candidate System 8 are also common to this system.

Candidate System 12 (Liquid Sludge for Agriculture)

WAS would be thickened and blended with raw primary sludge. The combination would then be anaerobically digested to recover methane gas and transported via pipeline to an agricultural area within Southern California. Liquid sludge delivered to the agricultural site would be stored in lagoons, prior to land application, to account for fluctuations in agricultural demand. The basic advantage of this system is that sludge is applied as a liquid, which would eliminate the need for dewatering equipment. However, the distribution of sludge at the agricultural site is likely to be more difficult than if a dewatered and dried product were applied. Also, transportation costs, groundwater impacts, environmental impacts, and potential public health effects are important. considerations.

Candidate System 13 (Solar Drying on San Clemente Island)

WAS would be thickened and blended with raw primary sludge. The combination would then be anaerobically digested to recover energy, possibly thickened, and transported via pipeline to barge-loading facilities. Sludge would then be barged to San Clemente Island and pumped to storage facilities.

It was originally thought that liquid sludge could be used to reclaim depleted soils and restore disrupted habitat on the island. However, further study has indicated that large scale land reclaimation using liquid sludge would not be an altractive alternative because of limited land availability. The use of evaporation ponds to solar dry the liquid sludge, followed by composting of the dry product seems to be the most viable alternative. Composted product could then be returned to the mainland for resue. Areas of concern include transportation costs, overall energy needs, potential groundwater impacts, and compatibility with the U.S. Navy's Natural Resources Management Program.

Candidate System 14 (Thermal Pretreatment - Anaerobic Digestion)

Anaerobic stabilization of primary sludge generally results in about 50 percent reduction of organic material. This alternative is an approach designed to improve the biodegradability of organic sludges. It provides for thermal pretreatment of primary sludge, WAS, or both, prior to anaerobic digestion in existing digesters. Residual heat in the sludge after thermal pretreatment would be sufficient for digestion without additional heat

requirements. Placing thermal treatment before digestion may allow gas production to be maximized, while still providing the dewatering characteristics associated with heat-treated sludge and reducing the final mass of sludge remaining for disposal. After thermal pretreatment, the sludge would be completely sterilized. Other than this key process modification, Candidate System 14 is similar to Candidate System 8. Accordingly, it also shares the same concerns associated with Candidate System 8, except that there would be no public health concern over possible pathogenic organisms.

Candidate System 15 (Ocean Disposal)

This system would employ ocean disposal of anaerobically digested and screened sludges. Existing ocean outfall facilities could be used but other methods are also possible. Separate sludge outfalls discharging in deep ocean waters and barge discharge of liquid or dewatered sludge are included in this system. Major concerns are marine pollution and potential ecological effects.

Note that existing sludge disposal practices are in conflict with Federal and State policy regulations. In accordance with these policies, EPA and SWRCB have objected to the use of Clean Water Grant funds for study of systems for ocean disposal except the "no project" alternative, Candidate System 18. However, the three local agencies have agreed to fund studies of Candidate System 15 which is not eligible for Clean Water Grant funding.

Candidate System 16 (Exportation)

WAS would be thickened and blended with raw primary sludge. The combination would then be anaerobically digested and transported via pipeline to oil tanker loading facilities. Tankers would take on liquid sludge as ballast, following discharge of their crude oil, for the return trip to the oil exporting nations. This return trip is termed "empty haul" since no useful product is transported. The advantage of Candidate System 16 is that no additional energy would be required to transport liquid sludge in place of the normal sea water ballast and no liquid sidestreams would have to be treated. Conditions prevalent in oil exporting nations seem to indicate a potential market for soil conditioning materials such as digested sludge. However, market viability and transportation costs are areas of concern.

Candidate System 17 (Wet Air Oxidation)

Wet air oxidation is a method of chemically oxidizing organic matter in the liquid state. High temperature and pressure are used to encourage the oxidation of organics to carbon dioxide and water. The process is potentially energy self-sufficient. Only a sterile ash remains for disposal and, in this sense, wet oxidation is similar to other combustion processes.

A potential advantage of wet air oxidation is that water does not have to be removed from the sludge prior to oxidation and particulate and other air emissions are effectively controlled. Several by-product recovery processes have been proposed for the liquid sidestreams from this system. In addition to examining the same concerns associated with Candidate System 1, flexibility and reliability of this system are areas of concern.

Candidate System 18 (Baseline "No Project" Alternative)

The National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA) require that a "no project" alternative be included as part of all facilities planning. Following publication of the Phase I Report, a definition of the "no project" or baseline alternative applicable to the LA/OMA Project was developed. The resulting system was included as Candidate System 18. Since the baseline alternative must be included in any further analysis of systems, further definition of the system is provided in Chapter 3.

TABLE 2-1

CANDIDATE SYSTEMS COMPARISON - DATA SUMMARY
MONETARY COSTS, ENERGY, LAND USE, AIR EMISSIONS

DATA FROM REFERENCES 2 AND 3
LISTED IN APPENDIX B

CANDIDATE SYSTEM NO.	CODE[1]	SYSTEM DESCRIPTION	MONETARY COSTS ($/DRY TON) CAPITAL	O&M	TOTAL	ENERGY USE[2] (10^3MBTU/YR)	LAND ACQUISITION[3] (ACRES)	NET AIR EMISSIONS (lbs/day) PART.	TOTAL NO_X	SO_2
1	CTL	INCINERATION	13.82	37.74	51.56	(831)	0	1,600	3,940	2,760
2	CTL	PYROLYSIS	12.15	25.80	37.95	(1,436)	0	1,720	4,650	3,400
3	ETL	SEPARATE WAS TREATMENT	27.70	41.26	68.96	253	35(C)	1,410	1,410	(1,060)
4	ATL	CO-PYROLYSIS	6.33	22.53	28.86	(1,530)	83(C)	810	3,360	830
5	CTL	ACTIVE CHAR PRODUCTION	20.79	26.07	46.86	1,504	0	2,120	4,740	900
6	FTL	B.E.S.T. DEHYDRATION	15.39	38.28	53.67	781	0	30	5,090	3,040
7	ATL	CARVER-GREENFIELD MULTIPLE-EFFECT EVAPORATION	18.07	27.39	45.46	838	0	30	3,560	4,880
8	ATL	DEWATERING FOR LANDFILL OR AGRICULTURE	4.31	19.83	24.14	(1,786)	83(C)	60	2,120	120
9	CTR_C	SLUDGE RECYCLE CENTER	4.89	18.64	23.53	(1,719)	113(C)	60	2,200	530
10	ATL	EVAPORATION PONDS	12.04	11.22	23.26	(1,356)	3,000(R)	60	2,450	990
11	ATA_L	REMOTE DEWATERING	18.82	28.18	47.00	(704)	100(R)	60	3,080	1,850
12	APA_H	LIQUID SLUDGE FOR AGRICULTURE	21.15	1.03	22.18	(1,003)	25,900(A_H)	20	2,590	1,530
13	ABR_C	SAN CLEMENTE COMPOST	11.30	30.11	41.41	(1,273)	1,000(R)	320	3,690	740
14	FTL	THERMAL CONDITIONING ANAEROBIC DIGESTION	8.42	11.30	19.72	(2,326)	0	120	2,310	(70)
15	BPO	OCEAN DISPOSAL	8.26	(4.05)	4.21	(2,044)	0	15	1,120	(380)
16	ABL	EXPORTATION	2.77	13.42	16.19	(2,128)	0	0	1,590	50
17	ATL	WET AIR OXIDATION	16.15	13.53	29.68	446	0	40	3,870	3,480
18	ATL	NEPA-CEQA NO PROJECT	2.28	13.50	15.58	(1,878)	0	60	2,070	290

1. See text for explanation of coding system.

2. Energy units are in thousands of million BTU's/YR or 10^9 Btu/Yr. ( ) Indicates a surplus or credit of energy.

3. (C) Designates lands for composting near the plant,
(A_H) Designates farmland for high rate application,
(R) Designates other lands for sludge disposal remote from the plant sites.

COMPARISON OF THE CANDIDATE SYSTEMS

A summary of the quantitative and qualitative factors developed for each candidate system are presented in Tables 2-1 and 2-2. Quantitative factors include capital costs, operations and maintenance costs, and total costs, energy use or production, necessary land acquisition, and air emissions. Qualitative factors include environmental concerns, implementability, public health impacts, reliability, flexibility, land availability, land use effects, social impacts, and political constraints. Separate graphical presentations of capital costs, operation and maintenance costs, and energy consumption for each system are presented in Figures 2-1 and 2-2.

For each system a number of process, transportation and disposal permutations were considered. In all, over 250 permutations were evaluated during the analysis of the 18 candidate systems. The numerical and letter code shown in columns 1 and 2 of Tables 2-1 and 2-2 designates the candidate system and the particular permutations considered to be most attractive. The first number references the candidate system, the first letter designates a specific sludge processing sequence, the next letter indicates the transport mode, and the final letter defines the reuse or disposal technique. Sludge transport options are identified as truck (T), rail (R), pipeline (P), or barge (B). The reuse or disposal options can be identified as landfill (L), low-rate agricultural use (AL), high-rate agricultural use (AH), land reclamation (R), recycle center (Rc), or ocean (O).

The particular permutation of a candidate system considered to be most attractive was determined by assessing the factors of cost, energy consumption, air emission, land use, reliability and flexibility. In most cases the most attractive permutation was also the least cost permutation. It should be noted that the information presented in Tables 2-1, 2-2 and Figures 2-1 and 2-2 pertain only to the most attractive permutation. Further information regarding the other permutations, the criteria for selection, and the specific process sequences is contained in "Analysis of Candidate Systems and Preliminary Site Identification" by CH_2M-Hill.

Cost Data

All cost data are expressed in terms of dollars per dry ton of raw primary plus secondary sludge input to the system. Credit for existing baseline facilities was assumed in the cost analysis. Therefore, capital costs do not include the value of baseline facilities. Costs for operation and maintenance include operation of both new and baseline facilities because such costs will be incurred if the facilities are utilized. The value of energy produced as part of sludge processing is credited against the operating costs. Capital costs are based on an Engineering News Record Construction Cost Index (ENR CCI) of 2800, while operation and maintenance costs are based on a Consumer Price Index (CPI) of 170. Costs shown are comparative and are based on total, raw

TABLE 2-2

CANDIDATE SYSTEMS COMPARISON - DATA SUMMARY
QUALITATIVE FACTORS

DATA FROM REFERENCES 2 AND 3
LISTED IN APPENDIX B

CANDIDATE SYSTEM NO.	CODE	SYSTEM DESCRIPTION	ENVIRONMENTAL CONCERNS	IMPLEMENTABILITY	PUBLIC HEALTH IMPACTS	RELIABILITY	FLEXIBILITY	LAND AVAILABILITY	LAND USE EFFECTS
1	CTL	INCINERATION	AIR EMISSION POSSIBLE ODOR	VERY LOW	AIR QUALITY	HIGH	GOOD	EXCELLENT	MINOR
2	CTL	PYROLYSIS	AIR EMISSION POSSIBLE ODOR	VERY LOW	AIR QUALITY	FAIR (UNPROVEN)	GOOD	EXCELLENT	MINOR
3	ETL	SEPARATE WAS TREATMENT	AIR EMISSION POSSIBLE ODOR	VERY LOW	AIR QUALITY	GOOD	GOOD	GOOD	MINOR
4	ATL	CO-PYROLYSIS	AIR EMISSION POSSIBLE ODOR	VERY LOW	AIR QUALITY	GOOD	GOOD	GOOD	MINOR
5	CTL	ACTIVE CHAR PRODUCTION	AIR EMISSION POSSIBLE ODOR	VERY LOW	AIR QUALITY	FAIR	HIGH	EXCELLENT	MINOR
6	FTL	B.F.S.T. DEHYDRATION	AIR EMISSIONS	VERY LOW	AIR QUALITY	FAIR (UNPROVEN)	FAIR	EXCELLENT	MINOR
7	BTL	CARVER-GREENFIELD MULTIPLE-EFFECT EVAPORATION	AIR EMISSIONS	VERY LOW	AIR QUALITY	FAIR	GOOD	EXCELLENT	MINOR
8	ATL	DEWATERING FOR LANDFILL OR AGRICULTURE	TRAFFIC CONGESTION	FAIR	POSSIBLE VECTORS	HIGH	HIGH	FAIR	MODERATE
9	CTR_C	SLUDGE RECYCLE CENTER	TRAFFIC CONGESTION	LOW	POSSIBLE VECTORS	HIGH	HIGH	FAIR	MODERATE
10	ATL	EVAPORATION PONDS	PIPELINE CONSTRUCTON ODORS	GOOD	POSSIBLE VECTORS, POSSIBLE GROUNDWATER CONTAMINATION	HIGH	HIGH	FAIR	MINOR
11	ATA_L	REMOTE DEWATERING	PIPELINE CONSTRUCTION	VERY LOW	AGRICULTURAL USE OF SLUDGE	GOOD	HIGH	GOOD	BENEFICIAL
12	APA_H	LIQUID SLUDGE FOR AGRICULTURE	PIPELINE CONSTRUCTION SOIL PRODUCTIVITY	VERY LOW	VECTORS, AGRICULTURAL USE OF SLUDGE	HIGH	HIGH	POOR	DETRIMENTAL
13	ABR_C	SAN CLEMENTE COMPOST	PIPELINE CONSTRUCTION TRAFFIC CONGESTION	LOW	VECTORS, LIMITED PUBLIC CONTACT BARGE SPILL	GOOD	FAIR	FAIR	BENEFICIAL
14	FTL	THERMAL CONDITIONING ANAEROBIC DIGESTION	TRAFFIC CONGESTION AIR EMISSION	GOOD	AIR QUALITY	FAIR	GOOD	GOOD	MINOR
15	BPO	OCEAN DISPOSAL PIPELINE CONSTRUCTION	MARINE IMPACTS	VERY LOW	POSSIBLE EFFECTS ON FOOD CHAIN	HIGH	GOOD	EXCELLENT	MINOR
16	ABL	EXPORTATION	PIPELINE CONSTRUCTION	LOW	RELATED TO FOREIGN USE, TANKER SPILL	LOW	FAIR	GOOD	NONE LOCALLY
17	ATL	WET AIR OXIDATION	AIR EMISSIONS POSSIBLE ODOR TRAFFIC CONGESTION	FAIR	AIR QUALITY	LOW	LOW	EXCELLENT	MINOR
18	ATL	NEPA-CEQA NO PROJECT	MARINE IMPACTS	VERY LOW	POSSIBLE VECTORS	HIGH	HIGH	EXCELLENT	MINOR

1. Environmental and social concerns have been evaluated on a preliminary and broad basis only. Comprehensive analysis will be developed as part of the EIR/EIS process.

TABLE 2-2 (Con't)

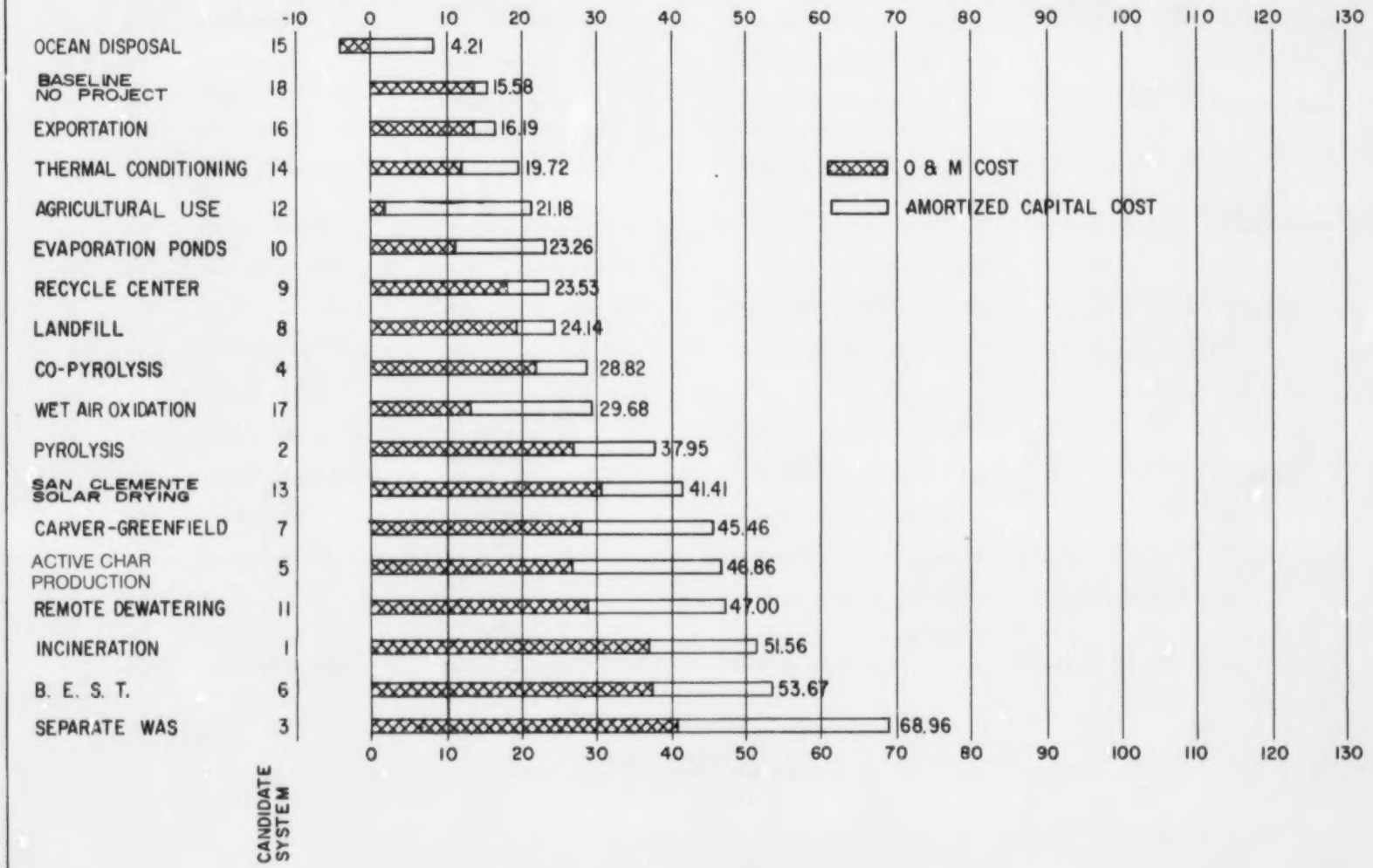
CANDIDATE SYSTEMS COMPARISON - DATA SUMMARY
QUALITATIVE FACTORS

DATA FROM REFERENCES 2 AND 3
LISTED IN APPENDIX B

CANDIDATE SYSTEM NO.	CODE	SYSTEM DESCRIPTION	SOCIAL CONCERNS	POLITICAL CONSTRAINTS	REMARKS
1	CTL	INCINERATION	AIR EMISSION, ODOR, TRUCK TRAFFIC NOISE	MAY ENTAIL CHANGE IN REGULATIONS	
2	CTL	PYROLYSIS	AIR EMISSION, ODOR, TRUCK TRAFFIC NOISE	MAY ENTAIL CHANGE IN REGULATIONS	UNPROVEN TECHNOLOGY
3	ETL	SEPARATE WAS TREATMENT	AIR EMISSION, ODOR, TRUCK TRAFFIC NOISE	MAY ENTAIL CHANGE IN REGULATIONS	
4	ATL	CO-PYROLYSIS	AIR EMISSION, ODOR, TRUCK TRAFFIC NOISE	MAY ENTAIL CHANGE IN REGULATIONS	POOPLY PROVEN TECHNOLOGY
5	CTL	ACTIVE CHAR PRODUCTION	AIR EMISSION, ODOR, TRUCK TRAFFIC NOISE	WOULD CHANGE EXISTING FACILITIES PLANS CHANGE IN REGULATIONS	COSTS REFLECT LIQUID WASTEWATER TREATMENT SAVINGS POTENTIAL WITH FULL SYSTEM
6	FTL	B.E.S.T. DEHYDRATION	AIR EMISSION, ODOR, TRUCK TRAFFIC NOISE	MAY ENTAIL CHANGE IN REGULATIONS	
7	BTL	CARVER-GREENFIELD MULTIPLE-EFFECT EVAPORATION	AIR EMISSION, ODOR, TRUCK TRAFFIC NOISE	MAY ENTAIL CHANGE IN REGULATIONS	UNPROVEN TECHNOLOGY
8	ATL	DEWATERING FOR LANDFILL OR AGRICULTURE	TRUCK TRAFFIC NOISE DUST	COMPOST SITE AVAILABILITY	POORLY PROVEN TECHNOLOGY
9	CTR_C	SLUDGE RECYCLE CENTER	TRUCK TRAFFIC NOISE DUST	COMPOST SITE AVAILABILITY, POSSIBLE CHANGE IN REGULATIONS	COMPOSTED SLUDGE MAY VIOLATE PROPOSED DEPT. OF HEALTH REGULATIONS
10	ATL	EVAPORATION PONDS	ODORS, LAND USE PIPELINE RIGHT-OF-WAY	MAY REQUIRE CHANGE IN REGULATIONS	
11	ATA_L	REMOTE DEWATERING	LAND USE, PIPELINE RIGHT-OF-WAY	POSSIBLE CHANGE IN FUTURE REGULATIONS	DIGESTED SLUDGE MAY NOT MEET PROPOSED HEALTH REGULATIONS AND WOULD USE 56,100 ACRES OF PRIVATE FARMLAND
12	APA_H	LIQUID SLUDGE FOR AGRICULTURE	LAND USE, PIPELINE RIGHT-OF-WAY	POSSIBLE CHANGE IN FUTURE REGULATIONS	
13	ADR_C	SAN CLEMENTE COMPOST	LIMITED PUBLIC CONTACT	COMMITMENT OF U.S. NAVY	
14	FTL	THERMAL CONDITIONING ANAEROBID DIGESTION	ODORS, AIR EMISSIONS, TRUCK TRAFFIC NOISE	COMPOST SITE AVAILABILITY	UNPROVEN TECHNOLOGY, BUT UNDER ACTIVE LA/OMA INVESTIGATION
15	OF2	OCEAN DISPOSAL	MARINE IMPACTS	REGULATIONS PRECLUDE OCEAN DISPOSAL	
16	ADL	EXPORTATION	PIPELINE RIGHT-OF-WAY, DOCK CONSTRUCTION	MAJOR AND INTERNATIONAL IN SCOPE	ALL POTENTIAL DISPOSAL/REUSE OPERATIONS BEYOND LA/OMA AGENCY CONTROL
17	ATL	WET AIR OXIDATION	ODORS, TRUCK TRAFFIC NOISE	MAY ENTAIL CHANGE IN REGULATIONS	
18	ATL	NEPA-CEQA NO PROJECT	MARINE IMPACTS	REGULATIONS PRECLUDE OCEAN DISPOSAL	WOULD REQUIRE CHANGE IN REGULATIONS

FIGURE 2-1

COMPARATIVE COSTS OF CANDIDATE SYSTEMS


DOLLARS/TON DRY RAW PRIMARY AND SECONDARY SOLIDS
-10 0 10 20 30 40 50 60 70 80 90 100 110 120 130
OCEAN DISPOSAL 15 4.21
BASELINE NO PROJECT 18 15.58
EXPORTATION 16 16.19
THERMAL CONDITIONING 14 19.72
AGRICULTURAL USE 12 21.18
EVAPORATION PONDS 10 23.26
RECYCLE CENTER 9 23.53
LANDFILL 8 24.14
CO-PYROLYSIS 4 28.82
WET AIR OXIDATION 17 29.68
PYROLYSIS 2 37.95
SAN CLEMENTE SOLAR DRYING 13 41.41
CARVER-GREENFIELD 7 45.46
ACTIVE CHAR PRODUCTION 5 46.86
REMOTE DEWATERING 11 47.00
INCINERATION 1 51.56
B. E. S. T. 6 53.67
SEPARATE WAS 3 68.96
0 & M COST
AMORTIZED CAPITAL COST
CANDIDATE SYSTEM

LA/OMA PROJECT

sludge loads, inclusive of credits for energy recycle or reuse and exclusive of the value of baseline facilities. Therefore, the reader is cautioned that the results may not be directly comparable to other cost estimates developed for other situations.

Energy Factors

Energy use data contained in Table 2-1 and Figure 2-2 represents the net energy consumed or produced by the candidate system. Energy uses for sludge processing, transportation, and ultimate disposal have been included. Equivalent BTU's have been calculated for different energy forms. For example, electrical energy was converted to equivalent fuel by assuming a relationship of 1 KWH generated per 10,000 BTU of fuel consumed. The latter represents the approximate thermal efficiency of fossil fuel power plants, the major source of electrical energy in Southern California.

Anaerobic digestion and certain thermal processes produce energy from organics contained in sludge. Therefore, many of the candidate systems result in a net production of energy. Historically energy produced from anaerobic digestion in the LA/OMA study area has been used to offset the energy demands of sewage treatment. Even though energy may be produced during sludge processing the energy will continue to be used within the treatment plants. Little or no energy will be available for use outside the plants. Therefore, any sludge processing system which produces less energy compared to other systems will lead to increased consumption of outside energy sources in the remainder of the treatment plant.

Air Quality

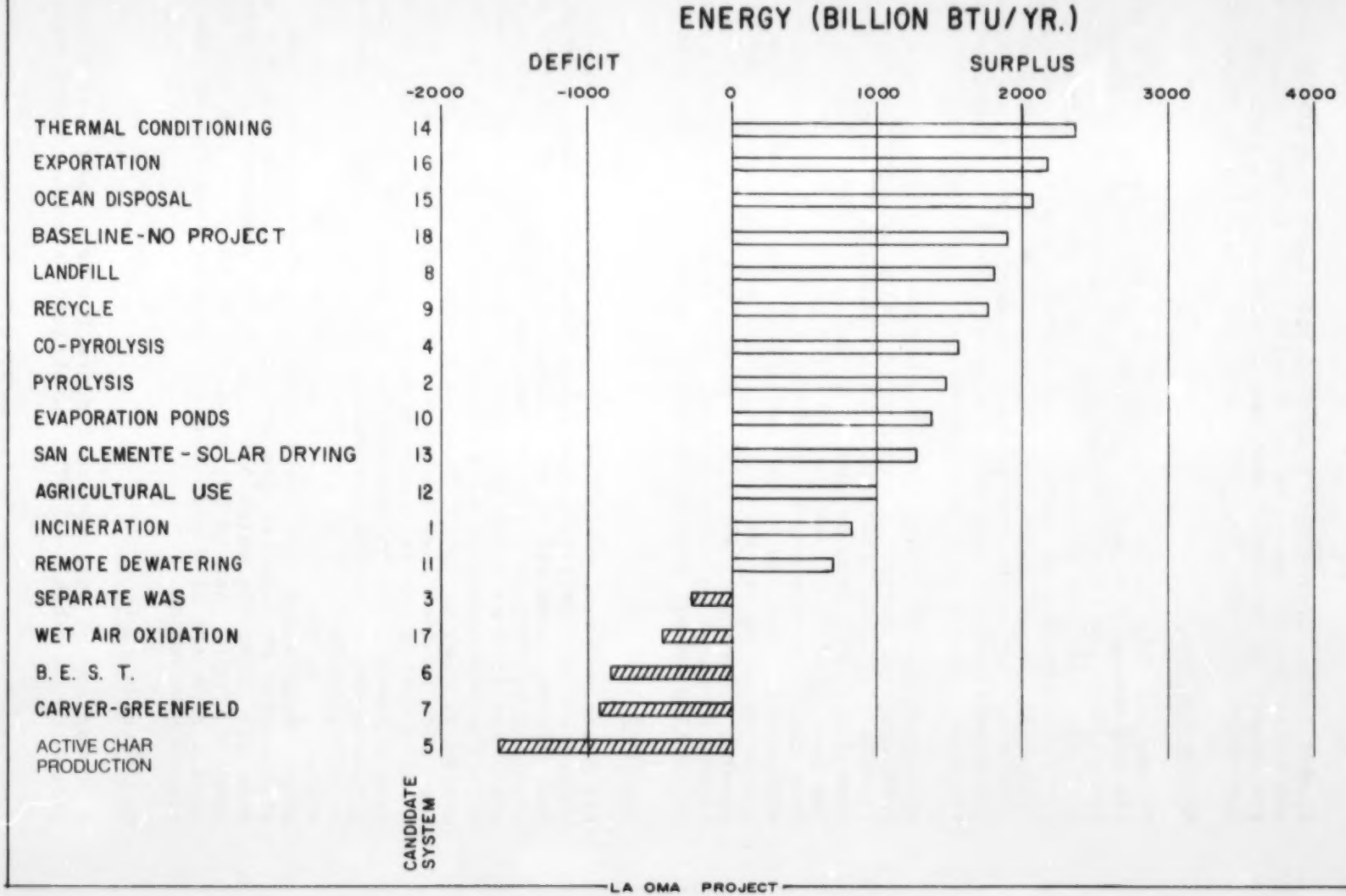
Air emissions were evaluated for particulates, NOx, and SO_2 constituents. Emissions generated from processing, transportation, and ultimate disposal of the sludge were included. Electrical power consumed by each candidate system was assumed to be generated at local fossil fuel steam generating plants. Indirect air emissions from the generation of this electricity were included in the analysis. Gas produced during anaerobic digestion is a low sulfur fuel and, as described above, will be used to partially meet energy demands within the treatment plants. Therefore, an air emission credit was applied to account for the fact that digester gas produced during sludge processing will reduce the consumption of other fuels, such as petroleum oils, which are not as clean burning. In some cases a net reduction in SO_2 emissions is shown which means that the reduction in SO_2 emissions from utilization of digester gas in place of petroleum oil is greater than all other SO_2 emissions from sludge processing. It does not, however, imply that no SO_2 emissions would occur but only that the credit from use of digester gas is greater than the emissions from sludge processing.

Qualitative Factors

A comparison of qualitative factors for each candidate system is presented in Table 2-2. The qualitative statements for each

FIGURE 2-2

ENERGY BALANCE FOR CANDIDATE SYSTEMS



candidate system, with the exception of Candidate System 15 - Ocean Disposal, are as presented in the CH_2M-Hill Report. The qualitative statements for Candidate System 15 were developed by LA/OMA Project staff using the same criteria employed by CH_2M-Hill. No attempt has yet been made to develop the environmental concerns regarding ocean disposal.

Conclusions

Evaluation of the data presented in Tables 2-1, 2-2 and Figures 2-1 and 2-2 indicates that those candidate systems which utilize high energy consuming processes are also less attractive both from the standpoint of capital costs and environmental effects. Systems which employ anaerobic digestion are, in general, more attractive because of the existing digester capacity and the economic value of the bio-fuel produced. Other conclusions developed from these studies are detailed in Chapter 1.

IDENTIFICATION OF LESS ATTRACTIVE SYSTEMS

Based on the CH2M-Hill analysis and other LA/OMA studies and demonstrations, each candidate system was assessed according to the quantitative and qualitative factors previously discussed. Those candidate systems judged to be less attractive for the LA/OMA study area are described in this section along with reasons for the decision. Remaining candidate systems were assembled into the sludge management alternatives described in Chapter 3.

Candidate System 1 - Incineration

Candidate System 1 provided for sludge conditioning, dewatering, and incineration, with ash disposal to a landfill. Incineration would be conducted in a multiple hearth, fluidized bed or rotary kiln reactor. As conventionally practiced, excess air would be supplied to assure complete combustion.

Conventional incineration is not recommended as a sludge management alternative for the following reasons. First, the objective of sludge volume reduction can be accomplished by other thermal processes such as pyrolysis or starved air combustion. The latter processes offer several advantages over conventional incineration including potential reduction in air emissions and improved thermal efficiency. Second, starved air combustion has been field tested at the Contra Costa Sanitary District and is the recommended system for the New York area. Third, conventional incineration is unlikely to be implemented in Southern California because of air quality constraints and the long history of opposition to such processes. Therefore, it is recommended that thermal processing by pyrolytic or starved air systems be further investigated and that conventional incineration not be given further consideration.

Candidate System 6 - B.E.S.T. Dehydration Process

Analysis by CH_2M Hill indicates that the B.E.S.T. system, marketed by Resources Conservation Co., would be comparable in cost to the Carver-Greenfield system. Both processes can potentially produce a similar dry product with 90+% solids.

A disadvantage of the B.E.S.T. process is that it has not been demonstrated on a full scale basis; whereas, the Carver-Greenfield process (Candidate System 7) has been used in the food industry, in some cases on wastes similar to municipal sludges. To date, all information on the B.E.S.T. process has been developed with a pilot scale system. No full scale plants are under design at this time. Therefore, the reliability of the B.E.S.T. process will be difficult to determine and implementation on a full scale basis for all LA/OMA sludge is not considered practical at the present time.

It is recommended that the B.E.S.T. process not be included as part of a sludge management alternative. A pilot demonstration for Maryland Environmental Services is currently scheduled by

Resource Conservation Co. and it is recommended that results of the project be carefully reviewed and that a reevaluation of this recommendation be made at that time.

Candidate System 11 - Remote Dewatering for Landfill or Agriculture

The basic concept of this system is that central mechanical dewatering facilities, close to the point of final reuse or disposal, may be attractive under certain economies of scale and reduction in transportation costs. The centralized facilities could be located in either a local urban or remote rural area. For the case of remote sites, however, the system is not recommended for further study for the following reasons. First, remote dewatering outside the urban area is technically attractive but centrate produced during dewatering would have to be handled, probably by use of evaporation ponds. If evaporation ponds are used for centrate dewatering, they might as well be used to dewater the feed sludge and avoid the need for mechanical dewatering entirely. Evaporation studies are currently being conducted to determine whether sludge solids will interfere with evaporation. Second, dewatering by evaporation ponds would be less expensive than mechanical dewatering at a remote site and would consume less resources since solar energy would be used in the evaporation.

A centralized dewatering facility located at a suitable industrial site within the urban area offers some potential advantages. Suburban development has encroached on all the treatment plants since their original development. Furthermore, available land is limited at each treatment plant, particularly for processes such as composting which have a high land requirement. Therefore, if sufficient land were available at an industrial or other suitable site, centralized dewatering and composting may be attractive. In this case, centrate could be returned to the treatment plants without the need for evaporation ponds. This concept has been included in the sludge management alternatives described later.

Candidate System 16 - Exportation

Preliminary studies and contact with individuals actively pursuing the exportation concept have indicated the following. First, exportation is considered by many to be a viable and attractive concept. Sufficient tanker capacity may be available in the Los Angeles-Long Beach area to handle most, if not all, of the LA/OMA sludge. Second, if exportation were implemented, a backup system would be required to assure proper sludge management in the event of embargo, market breakdown, etc. Third, because of marketing uncertainties and the need for foreign negotiations, it is difficult to judge whether the plan could be successfully implemented.

It is recommended that continued study of exportation be conducted but that it not be considered a complete sludge management alternative. If further study shows the system to be viable, it can be incorporated as part of other sludge management alternatives as appropriate.

Candidate System 17 - Wet Air Oxidation

Wet air oxidation, also referred to as high pressure oxidation, offers potential for wet combustion of sludge organics with little or no air pollution, production of a sterile ash end product, and energy self-sufficiency. However, conventional wet air oxidation has had a poor record of reliability. Severe corrosion problems are encountered under the high temperature and pressure conditions necessary in the system. These considerations have led to a virtual abandonment of the process by the manufacturers of heat treatment equipment. It was included as a candidate system in the Phase I Report because a new process was being marketed by the Resource Recovery Systems Division of Barber-Coleman Company and a 16 tpd demonstration of the process was planned by EPA and the City of Philadelphia.

A number of events have occurred since the original analysis of the system. Barber-Coleman Co. discontinued development and marketing of the system in August 1976. Equipment housed at their test facility in Irvine, Ca. has been disassembled and there are no plans to market the system in the future. In conjunction with the corporate actions by Barber-Coleman, the proposed demonstration project in Philadelphia has been abandoned.

It is recommended that Candidate System 17 be eliminated from further consideration for the following reasons. First, the Barber-Coleman System, which was designed to overcome the corrosion problems associated with wet oxidation, is no longer marketed. Other equipment on the market has, in general, been unreliable. Second, cost analyses indicate that wet air oxidation is not as cost effective as other more reliable processes. Third, energy recovery from the wet oxidation system has not been demonstrated on a practical basis. Fourth, potential for recovery of by-products was considered by CH_2M-Hill, but was judged to be uneconomical based on preliminary investigations of resource recovery in Philadelphia.

Recently, contact was made with the group who are actively pursuing yet another new concept for wet air oxidation. Their progress will be observed to determine if a reevaluation of the above recommendation is necessary.

CHAPTER 3

SLUDGE MANAGEMENT ALTERNATIVES

This chapter describes the six sludge management alternatives which are to receive detailed evaluation during the remainder of the LA/OMA Project. They may be modified or additional alternatives could be developed as a result of public review of this report. The alternatives will be subjected to thorough analysis and evaluation during the course of preparation of the Project Report and Environmental Impact Statement for the sludge management program and plan for the los Angeles Orange County Metropolitan Area.

Formulation of Alternatives

The quantitative and qualitative factors analyzed for each of the eighteen candidate systems and reported in Chapter 2 of this report are the basis for development of the sludge management alternatives. Primary attention of that analysis was focused on the factors of economic costs, energy consumption, implementability, and reliability. The reasons for this emphasis are--

* The development of the candidate systems was designed to eliminate systems which were judged to have obvious significant adverse social environmental effects.

* The evaluation of environmental and social factors during the analysis of candidate systems were largely qualitative in nature and not sufficiently detailed to support judgments as to elimination of systems.

* Distinctions between candidate systems on the basis of economic costs, energy, implementability, and reliability were sufficiently well defined to allow formulation of sludge management alternatives based primarily on consideration of those factors.

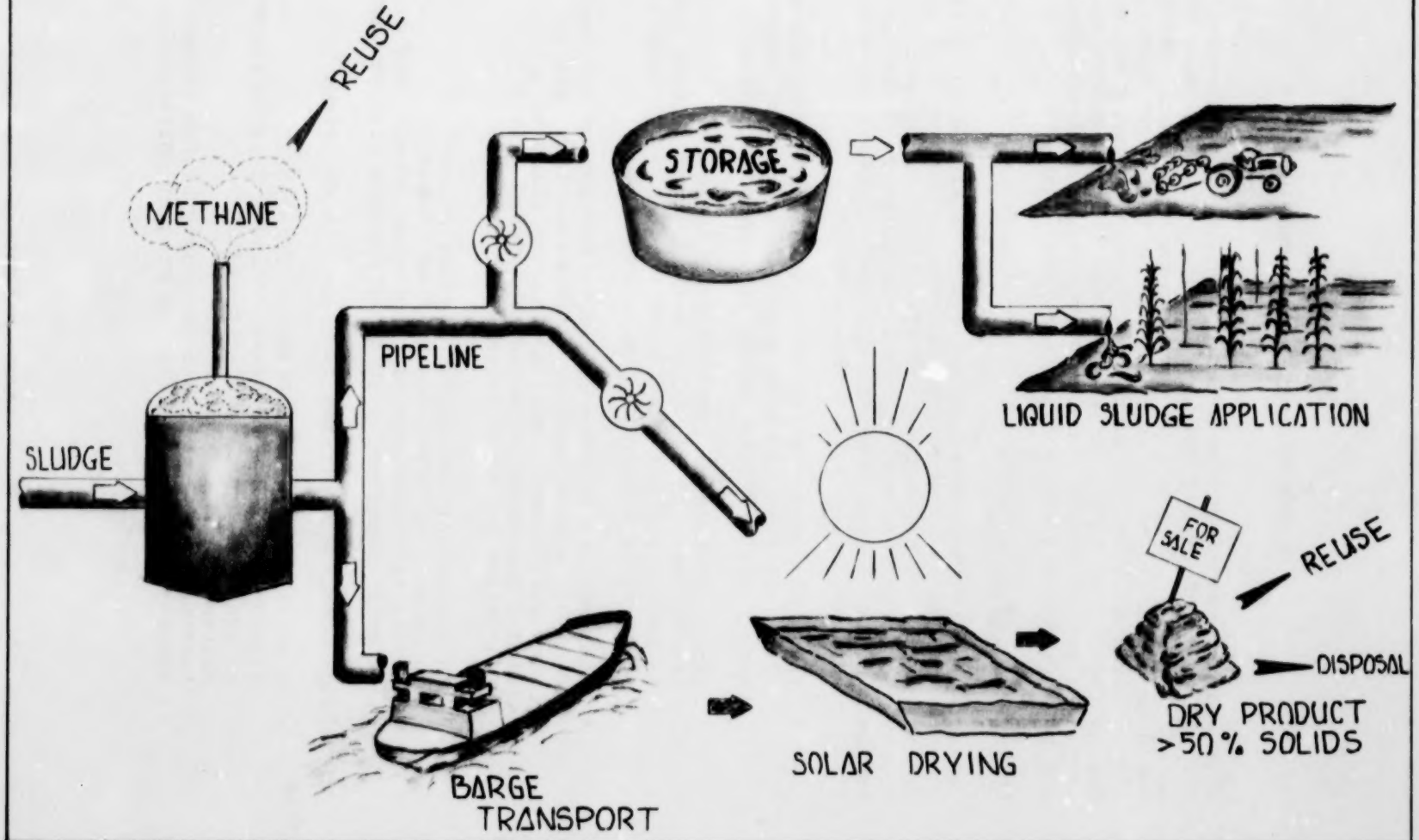
* Environmental and social factors of each of the sludge management alternatives will be evaluated in great detail during the remainder of the Project; thus, any significant effects associated with these factors will be identified.

The sludge management alternatives are listed below:

- Alternative 1 - Long Distance Transport
- Alternative 2 - Composting - Sludge Recycle Center
- Alternative 3 - Thermal Processing
- Alternative 4 - Ocean Disposal
- Alternative 5 - Separate Secondary Sludge Processing
- Alternative 6 - Baseline "No Project" Alternative

FIGURE 3-1

MANAGEMENT ALTERNATIVE 1
LONG DISTANCE TRANSPORT
SCHEMATIC DIAGRAM



MANAGEMENT ALTERNATIVE 1
LONG DISTANCE TRANSPORT

Alternative 1 is composed of all or parts of elements taken from the following candidate systems:

Candidate System 10 - Evaporation Ponds
Candidate System 12 - Liquid Sludge for Agriculture
Candidate System 13 - Solar Drying on San Clemente Island
Candidate System 9 - Sludge Recycle Center
Candidate System 14 - Thermal Pretreatment-Anaerobic Digestion

The common element in Systems 10, 12 and 13 is that sludge would be transported outside the urban area and either solar dried or used in a liquid form. Based on the CH_2M Hill analysis, pipeline transport is the most cost effective transport option for liquid sludge conveyed to the desert areas surrounding the Los Angeles-Orange County Metropolitan area. CH_2M Hill further recommended that the use of solar drying ponds on San Clemente Island be investigated. Barge transport is the only transport option if San Clemente is used as the site for solar drying. Other aspects of Candidate System 13 which pertains to soil reclamation on San Clemente Island have been deleted from consideration because of insufficient land availability.

The concept of dedicated land disposal of liquid sludge can also be incorporated into Management Alternative 1. In the option involving pipelining to desert areas, the liquid sludge would be stored and applied to land instead of solar drying. Cropping of the land would be optional.

Analysis by CH_2M Hill revealed that agricultural reuse of either liquid or dried sludge may be feasible in some areas if an irrigation water supply can be found. Therefore, the possibility of piping either primary or secondary effluent as a supplemental water supply will be investigated.

The concept of a sludge recycle center, Candidate System 9, involves providing sludge to marketing enterprises. Material which could not be marketed would be disposed at a landfill or by other land disposal methods. If sludge were to be pipelined to the desert areas and solar dried, the sludge recycle center could supply markets in the agricultural areas surrounding Southern California. If sludge were barged to San Clemente Island and solar dried, it could be transported back to the mainland for urban reuse.

Candidate System 14 provides for thermal conditioning of primary sludge, waste activated sludge, or both, prior to anaerobic digestion in existing digesters. The CH_2M Hill report concluded that the system was an attractive alternative capable of fulfilling sludge management needs. By necessity, the CH_2M Hill analysis was based primarily on the laboratory results obtained at Stanford

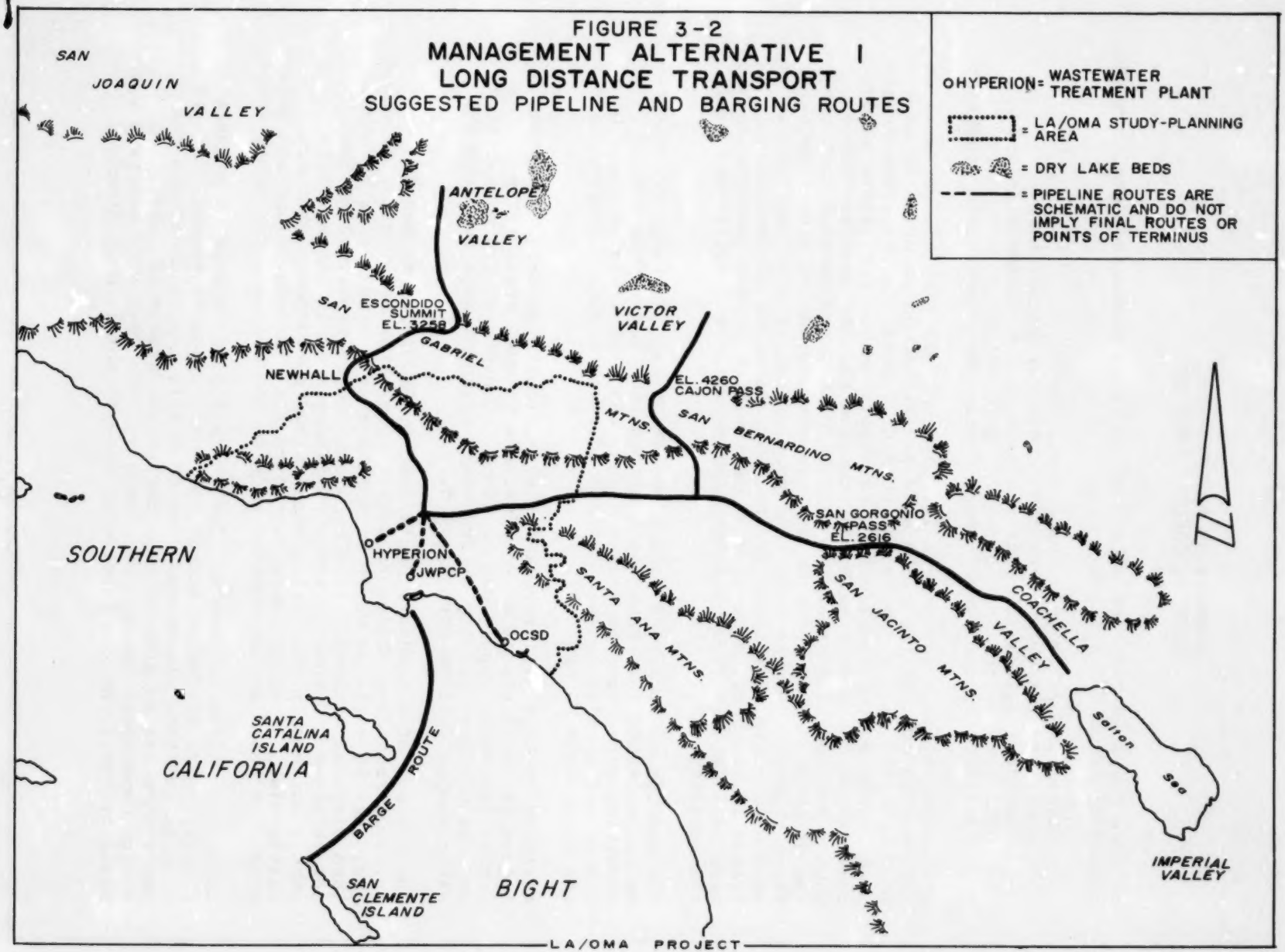


FIGURE 3-2
MANAGEMENT ALTERNATIVE I
LONG DISTANCE TRANSPORT
SUGGESTED PIPELINE AND BARGING ROUTES
HYPERION = WASTEWATER TREATMENT PLANT
= LA/OMA STUDY-PLANNING AREA
= DRY LAKE BEDS
= PIPELINE ROUTES ARE SCHEMATIC AND DO NOT IMPLY FINAL ROUTES OR POINTS OF TERMINUS
SAN JOAQUIN VALLEY
ANTELOPE VALLEY
SAN GABRIEL MTNS.
SAN ESCONDIDO SUMMIT EL. 3258
VICTOR VALLEY
NEWHALL
EL. 4260 CAJON PASS
SAN BERNARDINO MTNS.
SAN GORGONIO PASS EL. 2616
COACHELLA VALLEY
SOUTHERN
HYPERION
JWPCP
OCSD
SANTA ANA MTNS.
SAN JACINTO MTNS.
SALTON SEA
IMPERIAL VALLEY
SANTA CATALINA ISLAND
CALIFORNIA
BARGE ROUTE
SAN CLEMENTE ISLAND
BIGHT
LA/OMA PROJECT

University and further evaluation of this process, based on field results, is necessary. The final sludge product produced from Candidate System 14 would either be reused or disposed in a landfill. Since these ultimate disposal options are already a part of other sludge management alternatives, it is recommended that the concept of thermal pretreatment before anaerobic digestion be applied as a processing option elsewhere where appropriate. In the case of Management Alternative 1, thermal pretreatment may be applied for pathogen destruction or to improve the gravity thickening properties of the sludge to reduce barging costs.

Process Description

A process diagram for Management Alternative 1 is presented in Appendix A. A schematic diagram is shown in Figure 3.1. Secondary sludge would be thickened by dissolved air flotation, blended with primary sludge, and anaerobically digested to stabilize the sludge and recover methane gas as an energy source for in-plant needs. Thermal pretreatment may be utilized as deemed appropriate to pasturize the sludge and improve dewatering properties. Liquid digested sludge would then be transported outside the urban area via, pipeline or barge, to a site for solar drying or dedicated land disposal. A map showing possible pipeline and barging routes is shown in Figure 3-2. An advantage of producing a dry sludge product is that all subsequent transportation costs are reduced. With a dry product, low rate agricultural use or urban reuse are practical. Also, large land acquisitions on the part of the treatment agencies would not be required.

Evaporation in ponds is an attractive dewatering system, particularly in Southern California, since solar energy is used in the drying and no complex mechanical dewatering systems are required. Approximately 1000-3000 acres of ponds would be required to dry the sludge produced in the LA/OMA study area. Sludge which is solar dried would be available for reuse in the desert and agricultural areas or, in the case of San Clemente Island, transported back to the mainland for urban reuse. In all cases, sludge which could not be reused would have to be disposed in a landfill or by other acceptable means.

For the case where sludge is pipelined to the desert, an optional system would be to utilize the sludge in a liquid form for dedicated land disposal or committed agricultural use. Dedicated land disposal would involve high rate application of liquid sludge to land controlled by a public entity. Application rates of about 100 tons/acre/yr could be applied with total land requirements estimated at 5000 to 10,000 acres. Total application over the life of the project (i.e. years 1980-2020) would be about 4000 tons/acres. Land requirements would be significantly reduced if greater application rates could be used. Under the dedicated land disposal concept, cropping would not be practiced and therefore, supplementary irrigation water supplies would not be required.

Committed agricultural use implies that a public entity would control land committed to high rate agricultural use. Public control is considered desirable for at least three reasons: (1) to assure proper management of the liquid sludge application, (2) to assure a permanent site for sludge application, and (3) to control the selection of crops to be grown on the site. Land for cropping could be leased or rented to private concerns. Approximately 10,000 to 40,000 contiguous acres of land would be required for committed agricultural use. Contiguous ownership is considered desireable to minimize transportation problems associated with liquid sludge. In some areas a supplementary water supply would be required.

Affected Areas

This alternative could have application in several geographic areas outside of the Los Angeles-Orange County Metropolitan Area as well as the urban metropolitan area itself. In addition to the urban area, places which could be affected by this alternative include: the Antelope Valley, San Joaquin Valley, Victor Valley, Coachella Valley, the Mojave Desert, and San Clemente Island. These areas have been identified using the preliminary site identification information provided in the CH_2M-Hill report.

Major topics of concern when considering the implementation of this alternative include:

- -social and environmental aspects of evaporation and storage facilities
- -the marketability of sludge in agricultural usage
- -public health concerns regarding use of sludge for agricultural application
- -water quality impacts
- -pipeline construction impacts, and
- -energy requirements

MANAGEMENT ALTERNATIVE 2
COMPOSTING - SLUDGE RECYCLE CENTER

Sludge Management Alternative 2 is composed of all or parts of elements taken from the following candidate systems:

Candidate System 4 - Co-Pyrolysis with Refuse
Candidate System 8 - Dewatering for Landfill or Agriculture
Candidate System 11 - Remote Dewatering for Landfill or Agriculture
Candidate System 14 - Thermal Pretreatment - Anaerobic Digestion

The concept of co-pyrolysis, Candidate System 4, implies that sludge would be processed along with solid waste at a municipal refuse pyrolysis facility. Additions of small amounts of processed refuse to increase the fuel value of sludge is not a part of the co-pyrolysis concept but is considered under Management Alternative 3. Co-pyrolysis is generally attractive since sewage sludge is only a small fraction of the total solid waste generated in the study area. However, as a management alternative for sludge, co-pyrolysis is not considered practical at this time for a number of reasons: First, implementation of the co-pyrolysis concept is predicated upon solid waste management moving from the present landfill based system to large scale pyrolytic processes. Such a decision is beyond the control of the LA/OMA Project. Second, implementation of large scale, refuse pyrolysis systems will be subject to many factors including the availability of landfill sites, energy costs, system reliability, air pollution regulations, and so on. The course of such decisions is indeterminate at this time. Finally, large scale implementation within the immediate future seems unlikely in the Southern California area since the reliability of prototype systems has yet to be demonstrated. To accommodate the possible implementation of co-pyrolysis at a future date, organic sludge requiring disposal will be assumed to be landfilled or disposed of through co-pyrolysis at a municipal refuse pyrolysis facility, should the latter become a future reality in Southern California.

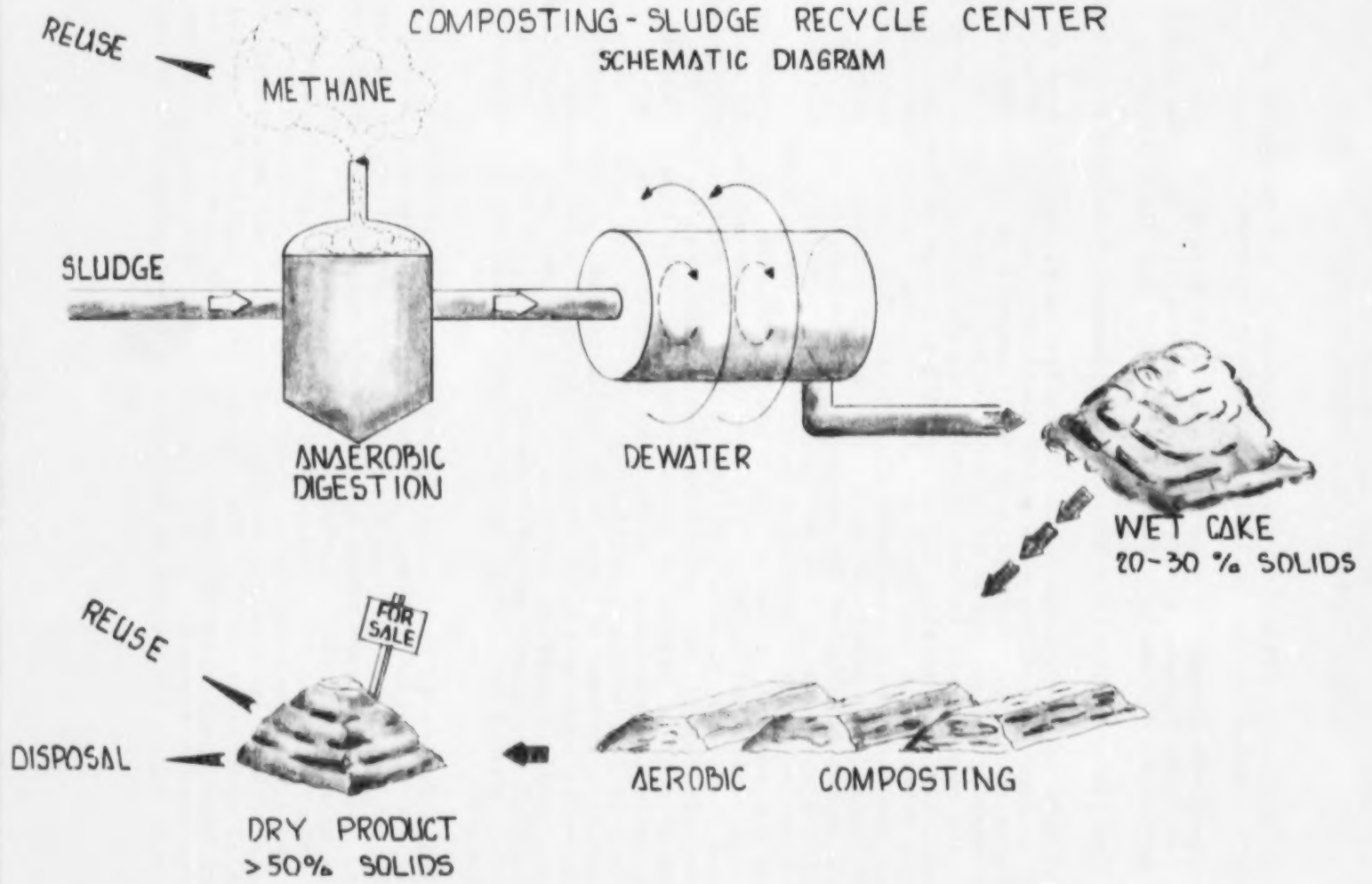
Candidate System 8, Dewatering for Landfill or Agriculture, provides for sludge digestion followed by dewatering with conventional dewatering equipment such as centrifuge, vacuum filter, or filter press. Dewatered cake would be ultimately disposed by landfilling in the urban area. This system represents a special case of Candidate System 9, the Sludge Recycle Center. CH_2M-Hill concluded that the Sludge Recycle Center appeared to offer an excellent compromise between landfilling of processed sludge and beneficial reuse of compost material. The concept can be applied to several sludge management alternatives. In the present case, it could be used to market a portion of the sludge within the urban area, the remainder being landfilled or disposed by other acceptable means.

FIGURE 3-3

MANAGEMENT ALTERNATIVE 2

COMPOSTING - SLUDGE RECYCLE CENTER

SCHEMATIC DIAGRAM



Process Description

A process diagram for Management Alternative 2 is presented in Appendix A. Secondary sludge would be dissolved air thickened, blended with primary sludge, and anaerobically digested. Thermal pretreatment may be employed, if appropriate, to pasteurize the sludge and improve dewatering properties. Alternatively, secondary sludge may be processed separately according to one of the process diagrams shown under Management Alternative 5.

Following anaerobic digestion the sludge would be chemically conditioned, dewatered, and composted. With the present windrow composting technique employed by the Los Angeles County Sanitation Districts, approximately 150 to 200 acres would be required to compost all digested sludge produced in the year 2020. Sufficient acreage to compost all sludge will not be available at the treatment plants after implementation of full secondary treatment. Additional sites for composting will be necessary.

Given the fact that additional land is needed for composting, it may be advantageous to purchase enough land to locate both the dewatering and composting facilities in a centralized location. Suburban development has encroached on all the treatment plants. Centralized facilities at an industrial or other comparable site would allow the processing operation to be conducted in a more suitable situation. Pipelines to transport sludge to the central facility would be required. An additional pipeline would be necessary to return the centrate produced during dewatering.

Whether the processing is conducted in centralized facilities or at the treatment plants, the composted product would be marketed via the sludge recycle center concept. Because of limitations imposed by transportation costs, major markets for the material are expected to be in the urban area. Low rate agricultural use might still be a possibility, however. Dewatered sludge or compost which could not be marketed would be disposed at a landfill or other solid waste disposal facility, such as a refuse co-pyrolysis facility.

Affected Areas

The processing of sludge under this alternative would occur wholly within the urban Los Angeles-Orange County Metropolitan Area. The recycle center(s) would most likely be located in the urban area, however, distribution points may be scattered throughout the marketing area.

Class I landfills are suitable for the disposal of dewatered sludge, however, their capacity is limited. It is expected that composted sludge could be disposed of in Class II landfills. Preliminary site identification research indicates that Class II capacity in the urban area would be sufficient for disposal of composted sludge.

Major topics of concern in the implementation of this alternative are:

- -impacts associated with landfill disposal
- -public health factors
- -land availability for composting
- -energy, and
- -marketability of the compost product.

MANAGEMENT ALTERNATIVE 3
THERMAL PROCESSING

Alternative 3 is comprised of all or parts of elements taken from the following candidate systems:

Candidate System 2 - Pyrolysis
Candidate System 5 - Active Char Process
Candidate System 7 - Carver-Greenfield Process

Candidate System 2, Pyrolysis, was considered in a number of different configurations in the CH_2M-Hill analysis: with and without anaerobic digestion and thermal versus chemical conditioning. The concept of adding processed refuse to increase the fuel value of sludge was also investigated.

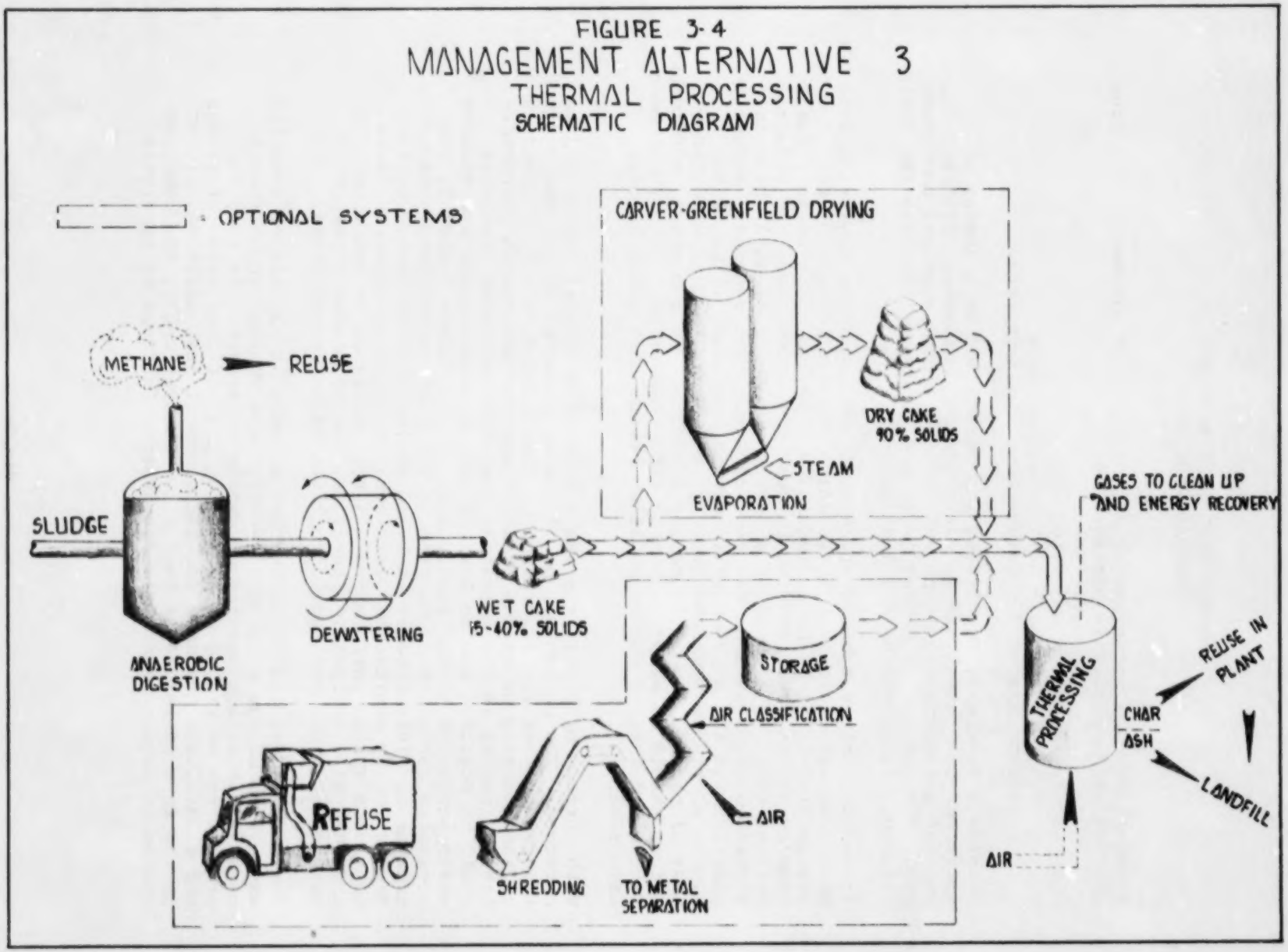
In general, those systems which employed anaerobic digestion were more cost effective than those which did not because of the energy credit for methane production. Refuse addition as a fuel supplement was also found to be cost effective since the refuse derived fuel (RDF) could be produced for about $1/MBtu which is significantly less than the cost of other fuel sources. Refuse addition for the purpose of increasing the fuel value of the sludge should be examined further including the cost effectiveness of various levels of refuse addition. As a minimum, sufficient refuse should be added to obtain auto-combustion. It has not been determined whether refuse addition beyond that point is cost effective.

With certain pyrolytic systems a form of activated carbon can be produced. The carbon may be of use if returned to the wastewater treatment plant for adsorption of dissolved organics. Depending on the quantity of carbon produced and its adsorption characteristics, saving in the operating cost for secondary treatment could be realized due to lowered oxygen requirements and reduced waste activated sludge production. In Candidate System 5, the activated carbon would be used in place of conventional secondary treatment. This process is being actively investigated by the Orange County Sanitation Districts. Sufficient operating data to assess system performance was not available at the time of the CH_2M Hill Analysis. Therefore, use of produced carbon in wastewater treatment should continue to be investigated.

The Carver-Greenfield dehydration process is capable of removing water from sludge with considerably less thermal input than is required in an incinerator or pyrolytic system. As such the process can be viewed as increasing the net fuel value of sludge and eliminating the need for supplemental fuel addition, either in the form of refuse or fuel oil. Theoretically, the combined system of Carver-Greenfield dehydration followed by pyrolysis

FIGURE 3-4

MANAGEMENT ALTERNATIVE 3
THERMAL PROCESSING
SCHEMATIC DIAGRAM



can be energy self-sustaining at digested solids contents less than 20 percent. Therefore, the Carver-Greenfield can be viewed as a method of efficiently reducing the moisture content of dewatered cake, increasing its net fuel value, and thus eliminating the need for supplemental fuel.

Based on the CH_2M Hill analysis, thermal processing was more expensive than many other candidate systems. However, many of the less costly candidate systems rely on landfilling or land disposal of processed sludge. Land availability and land use planning may pose problems in such systems. Therefore, it appears prudent to continue analysis of a thermal process, such as pyrolysis, which can greatly reduce the quantity of material remaining for land disposal and provide a reliable and safe product from a health standpoint. Additional benefits of thermal processing include destruction of pathogens and chlorinated organics such as PCB compounds, and the potential for energy recovery which could be used to offset energy demands within the treatment plant.

Process Description

A process diagram for Management Alternative 3 is presented in Appendix A. A schematic diagram is presented in Figure 3-4. Secondary sludge would be dissolved air thickened, blended with primary sludge, and anaerobically digested. Alternatively, secondary sludge may be processed separately according to one of the process diagrams shown under Management Alternative 5.

Following anaerobic digestion, the sludge would be conditioned and dewatered. Dewatered cake would be directly pyrolyzed, blended with RDF supplemental fuel and pyrolyzed, or dehydrated by the Carver-Greenfield process and pyrolyzed. Char produced during the pyrolysis may have use in the treatment plant as an activated carbon. Even if the char is reused, some will have to be continually removed to prevent buildup of ash within the process. Ash material would be disposed at a landfill or by other acceptable methods.

Potential energy recoveries from thermal processing will be examined. Possible recoveries include preheat of combustion air to the process, production of steam for electrical power generation, and production of pyrolytic fuels to offset in-plant power demands.

Management Alternative 3 would be conducted separately at the three major treatment facilities. Each plant is of sufficient size that maximum economics of scale will be realized. In all likelihood, a regional facility would be more costly because of the added transportation element needed to deliver sludge to the regional facility. Therefore, there does not appear to be any need for a regional facility processing the total sludge output.

Affected Areas

Processing of sludge under this alternative would occur wholly within the urban Los Angeles-Orange County Metropolitan Area.

Major topics of concern in the implementation of this alternative include:

- -air quality
- -system costs
- -economic efficiency, and
- -process reliability

MANAGEMENT ALTERNATIVE 4
OCEAN DISPOSAL

In 1972, the State Water Resources Control Board adopted the "Water Quality Control Plan for Ocean Waters of California." The Ocean Plan contains a prohibition of ocean disposal of sewage sludge based primarily on the presence of potentially toxic materials which may be harmful to marine biota. Furthermore, the "Federal Water Pollution Control Act Amendments of 1972" contain a requirement in Section 301 that effluent discharged from publicly owned treatment works must achieve effluent limitations based upon secondary treatment. Discharge of treated or untreated sludge which has been separated from the main sewage stream will not meet that requirement. There is currently no pending legislation to remove the secondary treatment requirement.

Since EPA is prohibited from using grant monies to fund any project which will not achieve such effluent limitations, no grant funds were authorized to study alternative ocean disposal practices. Because of this situation, the study performed by CH_2M Hill did not include an analysis of the ocean disposal alternative described as Candidate System 15.

It was felt, however, that a long range planning study, such as the LA/OMA Project, should examine all feasible reuse and disposal alternatives and that the Project should not be constrained to examine only the land and air environments as ultimate repositories for waste material to the exclusion of the water environment. Furthermore, the economic, environmental, and social costs of all alternatives should be documented so that society understands the total cost of the decisions which must be made regarding sludge management. Thus, to assure that all sludge management alternatives were investigated, the local operating agencies, the Los Angeles County Sanitation Districts, the City of Los Angeles, and the Orange County Sanitation Districts, provided separate funds for the study of ocean disposal alternatives.

Using these funds, LA/OMA staff completed a preliminary analysis of ocean disposal alternatives. Results of this analysis are contained in a separate technical report entitled "Preliminary Analysis of Ocean Disposal Alternatives." Fiscal cost, energy consumption and production, and air emission factors for a number of ocean disposal alternatives are included in that study. No attempt was made to document the environmental impacts of ocean disposal. The latter will be evaluated as part of other LA/OMA studies.

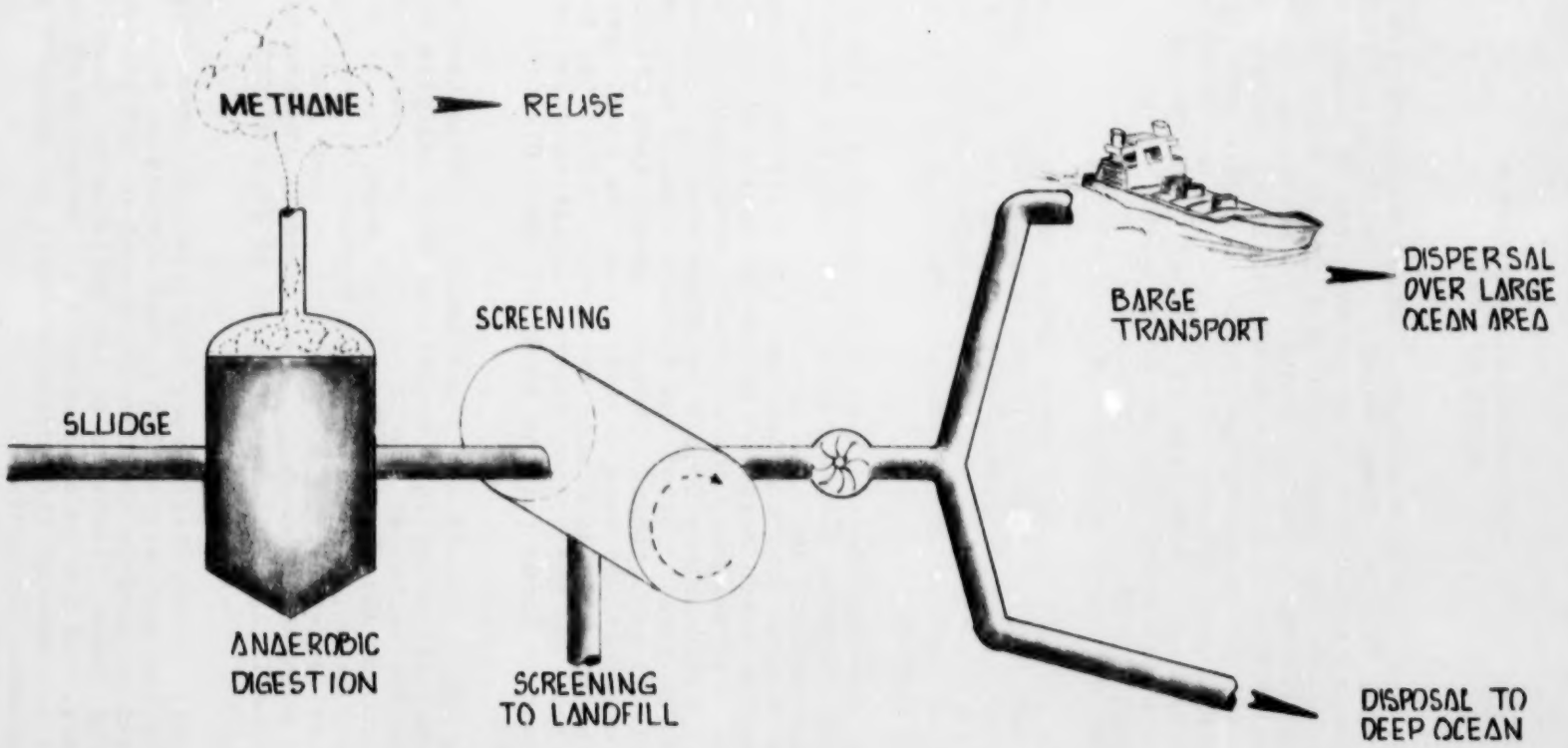
Results of the LA/OMA staff study indicate that ocean disposal is economically the most attractive system studied to date. It is also expected to produce the largest amount of net energy and will result in the lowest discharge of air pollutants. Considering these factors, and the need to examine all segments of the environment, it is recommended that ocean disposal be included as a sludge management alternative.

FIGURE 3-5

MANAGEMENT ALTERNATIVE 4

OCEAN DISPOSAL

SCHEMATIC DIAGRAM



Process Description

A process diagram of the ocean disposal alternatives is presented in Appendix A. A schematic diagram is shown in Figure 3-5. Secondary sludge would be dissolved air thickened, blended with primary sludge, stabilized by anaerobic digestion, and transported for ocean disposal. Two transport options are available, barge or ocean outfall.

If an ocean outfall were used, the system would probably be similar to that currently used by the City of Los Angeles. Depths and location of discharge would vary, however, depending on environmental and other factors. Depths of discharge would not be less than 300 feet and could possibly be extended to the deep basins with depths approaching 3,000 feet. A discharge depth of 1000 feet was assumed in developing the data presented in Chapter 2. With existing pipeline construction technology, it appears feasible to construct an ocean outfall to depths of at least 1000 feet.

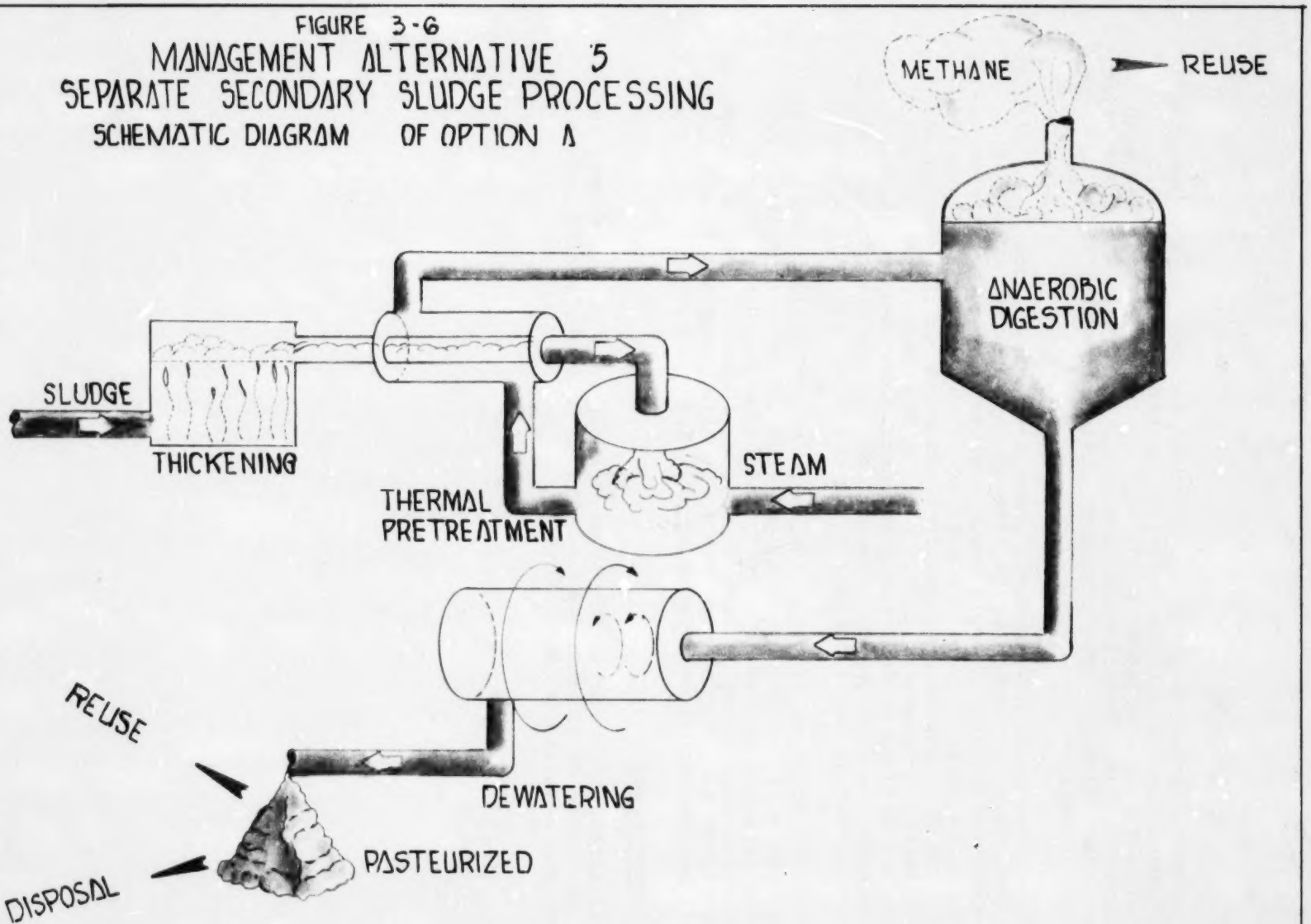
Barge transport would allow for dispersal of solids over a large area and would avoid any localized accumulation of solids. Preliminary analysis has indicated that barge transport is more expensive than ocean outfall transport. However, the environmental impacts of each method have yet to be determined and both options will be considered in subsequent analyses.

Affected Areas

This alternative would affect the Southern California Bight. The major issues of concern are the impacts upon the marine environment and regulatory constraints.

FIGURE 3-6

MANAGEMENT ALTERNATIVE 5
SEPARATE SECONDARY SLUDGE PROCESSING
SCHEMATIC DIAGRAM OF OPTION A



MANAGEMENT ALTERNATIVE 5
SEPARATE SECONDARY SLUDGE PROCESSING

Sludge Management Alternative 5 is composed of all or parts of elements taken from the following candidate systems:

Candidate System 2 - Pyrolysis
Candidate System 3 - Separate WAS Treatment
Candidate System 7 - Carver-Greenfield
Candidate System 9 - Sludge Recycle Center
Candidate System 14 - Thermal Pretreatment

It has become increasingly apparent that separate processing of secondary or waste activated sludge (WAS) may be desirable for several reasons. First, waste activated sludge adversely affects dewatering properties when blended with primary sludge. This effect has been demonstrated in several studies conducted by the operating agencies of the LA/OMA Project. Second, waste activated sludge has a higher fertilizer value than primary sludge, with nitrogen concentrations generally ranging between 5 and 8 percent. Due to the higher fertilizer value and the potential for increased monetary return on the product, it may be cost effective to process WAS by methods which would not be cost effective with primary or combined sludge. Third, interim sludge processing facilities are being designed, in most cases, to process primary digested sludge. Large expenditures to process WAS have generally not been committed. Therefore, alternative processing modes may be more attractive since existing facilities need not be credited in the economic analysis.

Candidate System 3, Separate WAS Treatment, was not found to be particularly attractive according to the CH_2M-Hill analysis. However, this conclusion applies only to the specific sequence of processes for Candidate System 3, as described in the Phase I Report. The conclusion does not apply to all methods of separate WAS processing. Therefore, it is recommended that Sludge Management Alternative 4 provide for separate processing of secondary sludge, recognizing the unique character of the latter material.

If separate secondary sludge processing is implemented, primary sludges would have to be processed by one of the other sludge management alternatives. For Management Alternative 1, Long Distance Transport and Management Alternative 4, Ocean Disposal, it is unlikely that separate WAS processing would be desirable. In both cases the sludges are used in the liquid state or dried by evaporation. Thus, the adverse dewatering characteristics of WAS are not an important consideration. Furthermore, separate processing would probably not be cost effective since only minor capital cost increases would be required to process both primary and secondary sludge together.

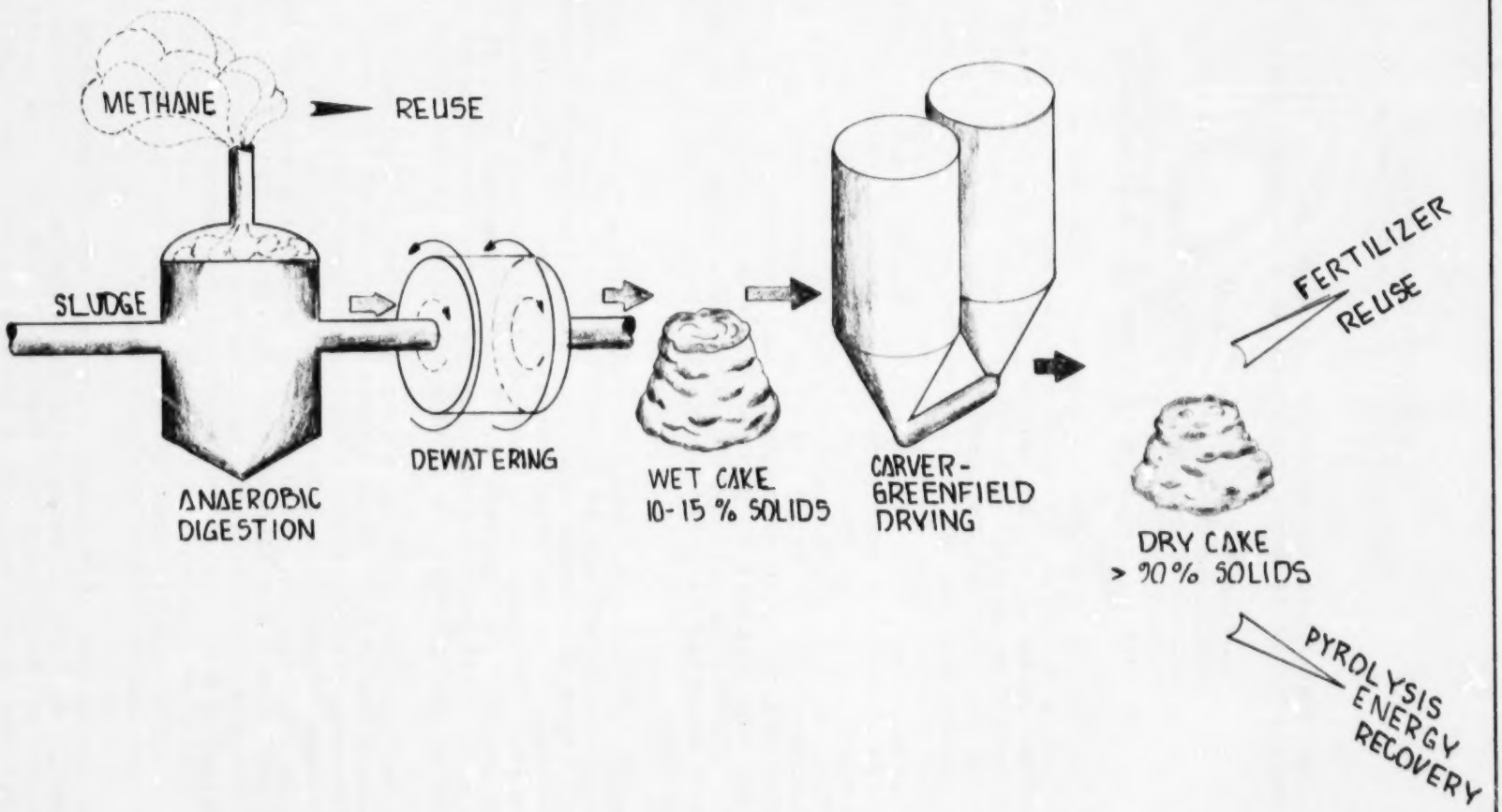
The advantages of separate secondary sludge processing are most readily applied to Management Alternative 2, Composting, Urban Reuse, and Management Alternative 3, Thermal Processing. Both alternatives use mechanical dewatering and significant capital

FIGURE 3-7

MANAGEMENT ALTERNATIVE 5

SEPARATE SECONDARY SLUDGE PROCESSING

SCHEMATIC DIAGRAM OF OPTION C



and operating cost reductions may be realized by separate WAS processing. Therefore, it can be assumed that separate secondary sludge processing would only be applicable if Management Alternatives 2 or 3 were implemented.

Process Description

Four separate options to process waste activated sludge have been identified. Each option is considered to be technically practical and, in addition, contains elements particularly attractive to the LA/OMA study area. Process diagrams for all options are presented in Appendix A. Schematic diagrams of Option A and C are presented in Figures 3-6 and 3-7, respectively.

Option A would provide for thermal pretreatment of the secondary sludge prior to anaerobic digestion. A field demonstration of this system is currently under investigation by LA/OMA. In laboratory studies significant increases in methane gas production were noted during anaerobic digestion of thermally pretreated waste activated sludge. Therefore, the potential exists for improved energy production. Another advantage of the system is that sludge is pasteurized during the thermal pretreatment process. Major objectives of the field demonstration are to determine the dewatering characteristics of the sludge after digestion and verify the laboratory findings. If good solids capture and cake solids can be obtained during dewatering, the sludge would be suitable for thermal processing or composting with marketing via the sludge recycle center concept. Regional facilities would not be required to implement Option A. All sludge processing, with the possible exception of dewatering and composting would be conducted at the individual treatment plants.

Option B would provide for thermal conditioning and dewatering of thickened waste activated sludge. Dewatered solids would be composted and marketed, truck hauled to a landfill, or thermally processed with remaining ash and char disposed to a landfill or by other acceptable means. An advantage of Option B is that good cake solids can be reliably obtained during dewatering of a thermally conditioned, secondary sludge. The liquid sidestream produced from dewatering, however, contains relatively high concentrations of soluble organics. To avoid excess oxygen demand on the secondary treatment facilities, some form of sidestream treatment should be employed prior to recycle to the plant. Treatment by anaerobic processes, as in a conventional digester or anaerobic filter, and lime treatment will be examined. Regional facilities would not be required to implement Option B.

Option C would provide for anaerobic digestion, chemical conditioning and dewatering of the secondary sludge. Dewatered cake would be dried utilizing the Carver-Greenfield process. The dry product would be suitable for reuse as a fertilizer or for thermal processing for energy recovery. One potential advantage of this system is the production of a high nitrogen end product, particularly if the sludge is not digested prior to the drying process. Nitrogen content of the dried sludge could be greater

than 5 percent which is sufficient for the material to be classified as a fertilizer. Substantial credit may be realized from the sale of such material, which would serve to offset the processing costs. Also, expanded marketing of the material, which would serve to offset the processing costs. Also, expanded marketing of the material may be possible because of the increased fertilizer value. A field demonstration of the Carver-Greenfield process is currently being conducted by LA/OMA to determine the acceptability of the process for sludge drying. Again regional facilities would not be required for implementation of Option C.

Option D would provide for pipeline transport of digested or raw waste activated sludge to storage facilities located outside the urban area. Possible pipeline routes would be similar to those shown in Figure 3-2. Storage facilities would be required to equalize the supply of sludge with the demand. Liquid sludge would be used for dedicated land disposal or committed agricultural use. The advantage of this system is that the high nitrogen content of secondary sludge is utilized without the need for mechanical dewatering or other sophisticated processing. Annual application rates based on nitrogen loading would be reduced because of the higher nitrogen content. However, this will also mean a larger acreage requirement and increased transportation costs. In all likelihood, regional facilities would be necessary because of the large capital investment required for implementation.

Affected Areas

The implementation of separate secondary sludge processing could affect areas both within and outside of the urban Los Angeles-Orange County Metropolitan Area depending upon the option which is chosen. Specific locations of applicability and major concerns associated with this alternative correspond to the alternative which is used for the processing of the primary sludge. Refer to the "affected areas" discussion of alternatives one, two, and three for the identification of specific areas and concerns.

MANAGEMENT ALTERNATIVE 6
BASELINE "NO PROJECT" ALTERNATIVE

The National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA) require that a "no project" alternative be included as part of any long range, facilities planning. The intent of this requirement is twofold: (1) to provide a baseline case from which to measure the economic, environmental, and other impacts of the alternative projects; and, (2) to determine the impacts if no projects were implemented.

Applying the "no project" concept to the LA/OMA study is complicated by the fact that interim solids processing facilities are being designed and constructed by the operating agencies. Secondary treatment facilities are also being designed and, in some cases, construction has commenced. Clearly, the term "no project" does not strictly apply in the case of the LA/OMA study since many projects which will produce sludge, and others which will process it, are currently being implemented. The term "baseline" alternative is more applicable since this alternative will serve as a baseline case from which to measure the economics and other impacts of alternative sludge management plans.

Based upon these considerations and recognizing that the LA/OMA Project is currently scheduled for completion in December, 1978, the baseline alternative has been defined as follows:

> "For purposes of comparison, the baseline alternative will assume full secondary treatment to be implemented in stages on or before 1983. Credit will be given for all primary and waste activated solids processing facilities in place, under construction, or contracted for construction as of December, 1978. Sludges beyond those which can be processed in the latter facilities will be assumed to be discharged through existing outfall facilities for ocean disposal."

Process Description

A process diagram for the baseline alternative is presented in Appendix A. Anaerobic digestion would continue to be used for sludge stabilization. Digested sludge would then be chemically conditioned, centrifuge dewatered, composted and landfilled. Marketing of compost product would continue in those cases where marketing is currently practiced. Digested sludge loads above the baseline dewatering capacity are assumed to be discharged to the ocean through existing ocean outfalls. Dewatered cake loads in excess of the baseline compost capacity are assumed to be truck hauled to existing landfills for disposal.

In order to coincide with completion of the LA/OMA Project, credit in economic analysis has been given for all solids processing facilities committed for construction prior to

FIGURE 3-8

MANAGEMENT ALTERNATIVE 6
BASELINE "NO PROJECT"

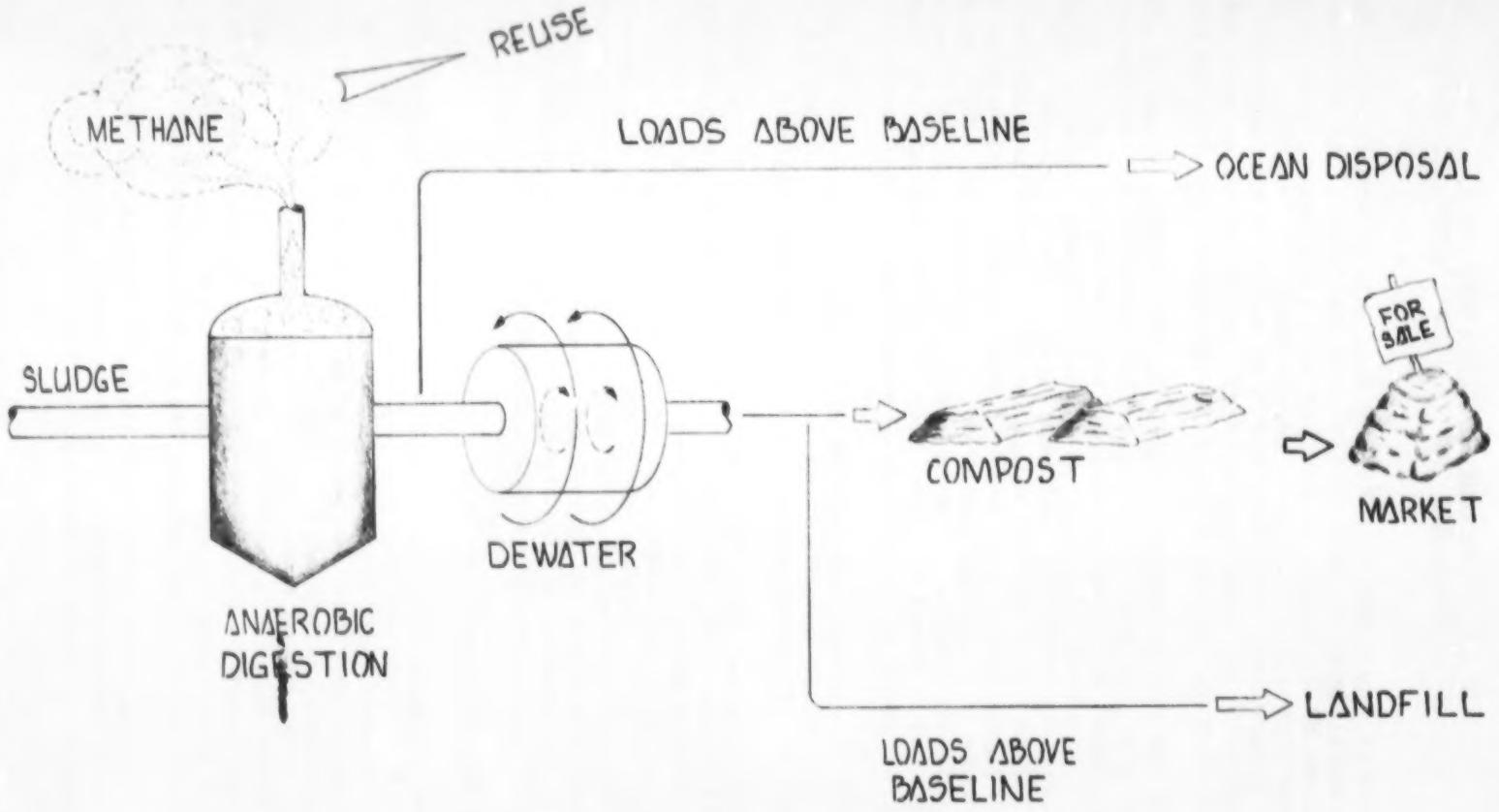


TABLE 3-1

ASSUMPTIONS USED IN ANALYSIS OF THE
BASELINE "NO PROJECT" ALTERNATIVE, MANAGEMENT ALTERNATIVE 6

A. LOS ANGELES COUNTY SANITATION DISTRICTS
Joint Water Pollution Control Plant

1. Total plant flow of 349 mgd in 1985.
2. Polymer addition to full plant flow followed by primary settling.
3. Secondary treatment for all primary effluent.
4. Separate anaerobic digestion of primary and waste activated sludges.
5. Dewatering of all digested primary in existing first and second stage solids processing facilities.
6. Dewatering of 101 tons/day of secondary sludge with 15 tpd liquid digested sludge discharged through the effluent outfalls to the ocean.
7. 368 tpd of combined sludge cake composted and sold to Kellogg Fertilizer Co. About 82 tpd of dewatered cake hauled to landfill.
8. Centrate blended with plant influent.

B. CITY OF LOS ANGELES
Hyperion Treatment Plant

1. Total plant flow of 366 mgd in 1985.
2. Full secondary treatment.
3. Anaerobic digestion of combined primary and waste activated sludges.
4. Centrifuge dewatering and landfilling for 26 tpd of combined digested sludge.
5. Ocean disposal of 229 tpd of screened digested sludge through the present 7-mile outfall.
6. Centrate blended with plant influent.

Terminal Island Treatment Plant

1. Full secondary treatment
2. Anaerobic digestion of combined sludges
3. Sludge dewatering and cake hauled to landfill
4. Treated centrate blended with plant influent

C. ORANGE COUNTY SANITATION DISTRICTS

1. Total flow to plants 1 and 2 of 215 mgd in 1985.
2. Full secondary treatment
3. Anaerobic digestion of all sludge
4. Centrifuge dewatering of all sludge with landfilling of 202 tpd of dewatered cake
5. Centrate blended with plant influent.

December, 1978. At the present time, committed facilities in 1978 can only be estimated and further refinements are to be expected. Specific assumptions regarding baseline facilities used in the CH_2M Hill analysis are summarized in Table 3-1. Based on these assumptions, the daily distribution of the combined 922 tons of digested sludge produced in 1985 would be as follows: 368 tons composted and marketed, 310 tons trucked to landfill, and 244 tons discharged to the ocean. Improved estimates of the baseline loads for different processes will be developed in future analyses.

Affected Areas

The continuation of present practices, the "no project" alternative would impact the marine environment, the urban area with regard to landfill locations, and the urban area with regard to the marketability of composted sludge. Since this alternative includes all methods of disposition associated with land and water, with the exception of high rate land disposal applications, the affected areas and major concerns identified for alternative two and four apply to this alternative.

CHAPTER 4
INTERIM WORK PLAN

The LA/OMA Project has been designed to allow for mid-course alteration of the work plan which was presented in the Phase I Report. This was done in recognition that tasks may change as the sludge management alternatives were developed and that they could not be forecasted with absolute certainty. The work summarized in Chapters 2 and 3 of this document have provided the information which is necessary to prepare a revision to the original work plan and budget.

This chapter provides documentation of changes which have been already made in carrying out Analysis I, those that are considered as appropriate in carrying out the remainder of the Project. It also indicates the status of the demonstration projects and provides an interim budget.

This chapter has been added to the report so that those persons who commented upon the Phase I Report and other members of the public have the opportunity to comment upon proposed revisions prior to their final adoption. The interim work plan and budget, as describedin this chapter, will be followed in carrying out LA/OMA Project during the months of May and June. At the regular meeting of the LA/OMA Policy Board on June 20, 1977, the work plan and budget will be reviewed and any public comments will be made known. During that meeting, it s anticipated that a revised work plan and budget will be adopted.

EXISTING WORK ELEMENTS

The status of technical studies conducted under work plan elements one through eight is present in Table 4.1. The original budget estimate, as given in the Phase I Report, is presented along with the current budget estimate and its current status. Comments on budgetary changes are given in Table 4.2.

The changes have been considered necessary based upon the following:

- -better estimates following development of detailed scopes of work,
- -elimination of certain demonstration projects no longer considered essential to development of sludge management alternatives,
- -changing certain tasks which were originally to be conducted by outside consultants to LA/OMA staff studies, and
- -for a limited number of tasks, a reduction in the scope of work based upon further study of actual needs.

TABLE 4.1
REVISIONS TO EXISTING WORK ELEMENTS
APRIL, 1977

Subelement	Description	Original Allocation	New Allocation	Project Status
1.1	Analysis I	100,000	n.c.*	complete
1.2	Analysis II	75,000	150,000	in progress
1.3	Analysis III	50,000	50,000	pending
2.1	Thermal Conversion Processes	45,000	35,000	in progress
2.2	Thermal Pretreatment	83,000	93,000	Task 2.2.1 complete Task 2.2.2 in progress
2.3	Dehydration Processes	160,000	100,000	Task 2.3.2 in progress Task 2.3.3 deleted
2.4	Compost Drying Studies	110,000	70,000	in progress
2.5	Evaporation Project	100,000	66,000	in progress
2.6	Miscellaneous Processes	43,000	15,000	pending
2.7	Mechanical Sludge Dewatering	50,000	30,000	in progress
3.1	Market Potentials	60,000	65,000	in progress
3.2	Potential for Exportation	15,000	-0-	in progress
4.1	U.C. Riverside Agricultural Project	250,000	263,000	in progress
4.2	Desert Reclamation	50,000	-0-	deleted
4.3	Landfill Disposal Project	145,000	60,000	pending
5.1	Existing Ocean Practices	40,000	45,000	pending
5.2	Alternative Ocean Practices	55,000	43,900	pending
5.3	Deep Ocean Outfall Systems	20,000	15,700	pending
6.1	Toxic Substances Review	20,000	-0-	in progress
6.2	Pathogen Survival Studies	40,000	40,000	in progress
6.3	Health Aspects Review	10,000	5,000	in progress
7.1	Sludge Characteristics Analysis	30,000	15,000	in progress
7.2	Impact of Source Control	25,000	-0-	in progress
8.1	Inventory of Site Information	30,000	30,000	complete
8.2	Detailed Site Analysis	100,000	100,000	pending

* no change

TABLE 4.2
COMMENTS ON REVISIONS SHOWN IN TABLE 4.1

Sub-element	Comments	Budget Change
1.2	Reflects needed for Step 1 facilities plan.	+75,000
2.1	Barber-Colman Demo, Task 2.1.4, deleted since firm has ceased marketing of pyrolytic system.	- 5,000
	Task 2.1.6, AWMD Review, reduced. Further study suggests that scope of work can be achieved at reduced cost.	- 5,000
2.2	Development of final scope of work for Task 2.2.2 resulted in slightly higher cost than originally estimated.	+10,000
2.3	B.E.S.T. Demo, Task 2.3.3, suspended pending results of pilot demonstration to be conducted by Maryland Environmental Services.	-60,000
2.4	Deep Pile Composting, Task 2.4.2, should be able to be completed at a reduced cost by changing the manner in which the work will be accomplished.	-40,000
2.5	Desert Evaporation Project can be accomplished at a reduced funding level.	-34,000
2.6	Puretec Demo, Task 2.6.1, cancelled since firm has discontinued marketing of the system.	- 3,000
	Hydrofracturing Assessment, Task 2.6.3, will be conducted by staff.	- 5,000
	Hydrofracturing Demo, Task 2.6.4, suspended pending results of the initial assessment.	-20,000
2.7	Review of scope of work indicates that initial budget estimate was high.	-20,000
3.1	Contingency funds have been added.	+ 5,000
3.2	Exportation to other countries is a question of marketing potential. These aspects will be handled in the existing Market Potential Study, Subelement 3.1.	-15,000

TABLE 4.2
COMMENTS ON REVISIONS SHOWN IN TABLE 4.1
(Continued)

Sub-element	Comments	Budget Change
4.1	Available information indicates need for budget increase.	+13,000
4.2	Desert Reclamation Project was to be conducted by UCR. It has been removed from the budget pending further results from the UCR Agricultural study, Subelement 4.1. At the present time it does not appear that Subelement 4.2 will be necessary to achieve the objective of developing guidelines for land application of sludge.	-50,000
4.3	Task 4.3.1, Literature Review and Analysis, will be conducted by agency staff at reduced cost.	-10,000
	Scope of work for Task 4.3.2, Field Demonstrations, has been defined and cost estimate is considerable less than original estimate.	-75,000
5.1	Development of final scope of work and contract negotiation resulted in slightly higher cost than	
5.2	Allocations reduced to cover estimated staff and project costs associated with grant ineligible studies.	-11,100
5.3	Allocating reduced to cover estimated staff and project costs associated with grant ineligible studies.	- 4,300
6.1	Mass balances for toxic substances to be conducted by project staff.	-20,000
6.3	Increased participation by governmental health officers has reduced the estimated costs for the Health Effects Advisory Committee.	- 5,000
7.1	Reassessment of actual work necessary to analyze sludge characteristics has resulted in lower cost.	-15,000
7.2	The impact of source control and pretreatment requirements on sludge characteristics will be studies by project staff. No reduction in the scope of work is anticipated.	-25,000
	original estimate	+ 5,000

NONSEWERABLE WASTE - ELEMENT 9

Element 9 in the LA/OMA Phase I Report contained a description of nonsewerable waste studies to be conducted by the LA/OMA Project. Such studies are important to the overall management of waste residuals. Many other liquid residuals, besides sewage sludge, are generated in the LA/OMA study area. These wastes are generally not acceptable for discharge to the sewer system and, therefore, have been termed nonsewerable wastes. At present, the primary method of ultimate disposal of nonsewerable wastes is at Class I landfill sites. However, capacity of existing Class I landfill sites is limited and a significant reduction in capacity is expected in the near future. Implementation of industrial pretreatment requirements is expected to increase the quantity of certain types of nonsewerable wastes. Since these wastes are liquid in nature, there is a possibility for combined disposal of both municipal and industrial sludges which offers potential for increased cost effectiveness. Forced with expected increases in the generation of nonsewerable wastes, the dimishing availability of Class I disposal sites, and the possibility for co-disposal, the LA/OMA Project proposed the nonsewerable waste studies presented as Element 9 in the Phase I Report.

Since development of the Element 9 studies a number of factors have developed to cause a change in the original work plan. The State Water Resources Control Board and the U.S. Environmental Protection Agency have expressed concern about funding such studies from the construction grant program. Agreement has been reached that Subelements 9.1, 9.2 and Task 9.3.1 would be grant eligible but a final decision on Tasks 9.3.2 and 9.3.3 is pending on the development of more detailed scopes of work. Concern has also been raised by the local agencies that the scope and magnitude of the nonsewerable waste disposal problem should be more clearly defined before implementation of actual field demonstrations.

TABLE 4.3
REVISIONS TO NONSEWERABLE WASTE STUDIES

Subelement	Description	Original Allocation	New Allocation	Status
9.1	Characterization and Quantification of Nonsewerable Wastes	$ 200,000	$ 100,000	pending
9.2	Impact of Industrial Source Control and Pretreatment Regulations	50,000	50,000	pending
9.3.1	Development of Conceptual Treatment and Disposal Alternatives	15,000	15,000	pending
9.3.2	Demonstration of Co-Disposal of Municipal and Nonsewerable Wastes on Dedicated Land	145,000	145,000	awaiting 9.1, 9.2 results
9.3.3	Management by Central Treatment Facility Concept	300,000	300,000	"
		$ 710,000	$ 610,000	

NEW WORK ELEMENTS

Elements 10 and 11 are new work elements which have been identified since preparation of the initial project budget.

Element 10, Environmental Studies ($100,000)

This element provides capability for performing the work necessary to describe the environmental setting associated with the various sludge management alternatives to develop evaluation and assessment criteria; and to identify environmental constraints affecting each sludge management alternative. Project staff will use this information in preparing the EIR/EIS document.

Element 11, Technical Assistance ($90,000)

During the course of the project, several small scale projects have been identified which should be considered for study.

Studies contemplated are:

(a) Impact of centrate recycle on effluent quality and sludge characteristics;

(b) Effects of increased digester detention time upon gas production and sludge dewaterability;

(c) Hydraulic characteristics of long distance pipeline transport of sewage sludge.

In addition, this element provides funds for (1) hauling of sludge for the various demonstration projects, (2) specialized consultant review of demonstration project results.

REVISED PROJECT BUDGET

Revised Project budget by work element is shown in Table 5.4. Both grant and non-grant eligible portions of the work are presented. Estimated total project expenditures remain at $3.4 million, the same as that originally estimated in the Phase I Report.

TABLE 4.4
REVISED PROJECT BUDGET
7-1-75 through 12-31-78
April, 1977

Item		Grant Fligible	Nongrant Eligible
Element 1	System Evaluation and Plan Formulation	$300,000	
Element 2	Process Performance Studies	409,000	
Element 3	Assessment of Market Potentials	65,000	
Element 4	Land Application Projects	323,000	
Element 5	Ocean Disposal Projects	45,000	$ 59,600
Element 6	Analysis of Public Health Factors	45,000	
Element 7	General Background Studies	15,000	
Element 8	Site Identification	130,000	
Element 9	Nonsewerable Waste Studies	610,000	
Element 10	Environmental Studies	100,000	
Element 11	Technical Assistance	90,000	
	TOTAL CONTRACTUAL SERVICES	$2,132,000	$ 59,600
Staff Studies and Management		654,600	15,400
Public Participation		295,000	
Temporary Help		10,000	
	TOTAL PROJECT STAFF SUPPORT	959,600	15,400
Contingency		233,400	
TOTAL PROJECT		$3,325,000	$ 75,000

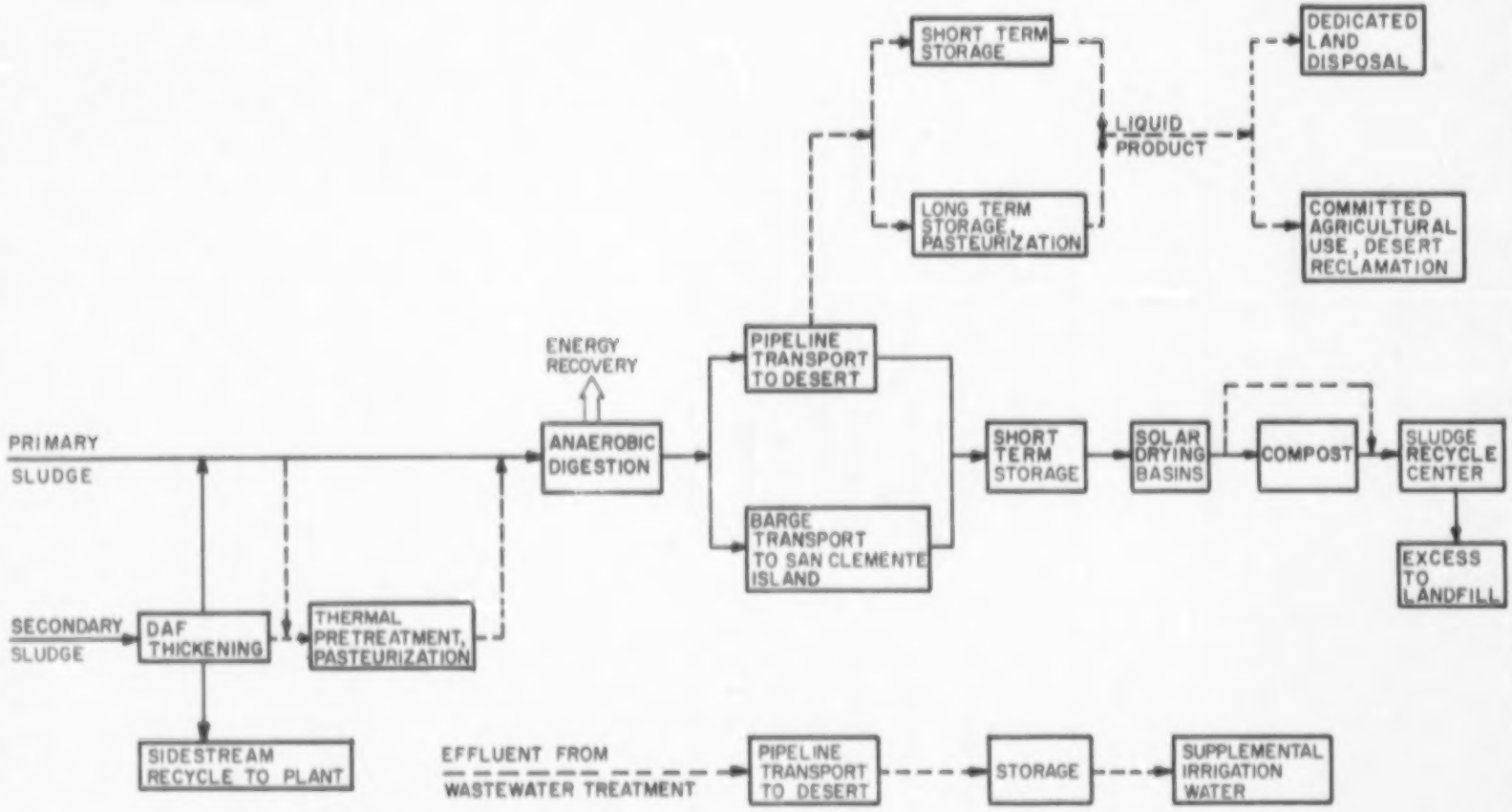
APPENDIX A

PROCESS DIAGRAMS
FOR EACH
SLUDGE MANAGEMENT ALTERNATIVE

Alternative 1	Long Distance Transport	Figure A-1
Alternative 2	Composting - Sludge Recycle	Figure A-2
Alternative 3	Thermal Processing	Figure A-3
Alternative 4	Ocean Disposal	Figure A-4
Alternative 5	Separate Secondary Sludge Processing, Options A and B	Figure A-5
Alternative 5	Separate Secondary Sludge Processing, Options C and D	Figure A-6
Alternative 6	Baseline "No Project"	Figure A-7

FIGURE A-1

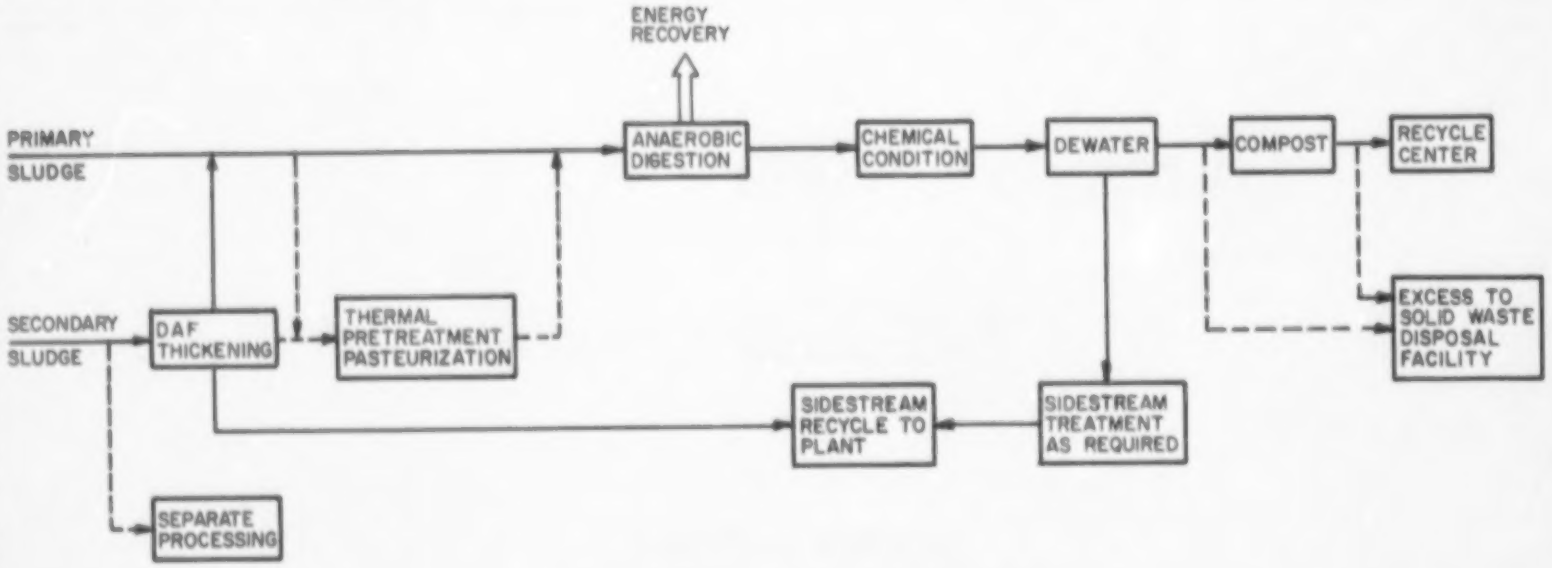
MANAGEMENT ALTERNATIVE I
LONG DISTANCE TRANSPORT
PROCESS DIAGRAM



LA/OMA PROJECT

FIGURE A-2

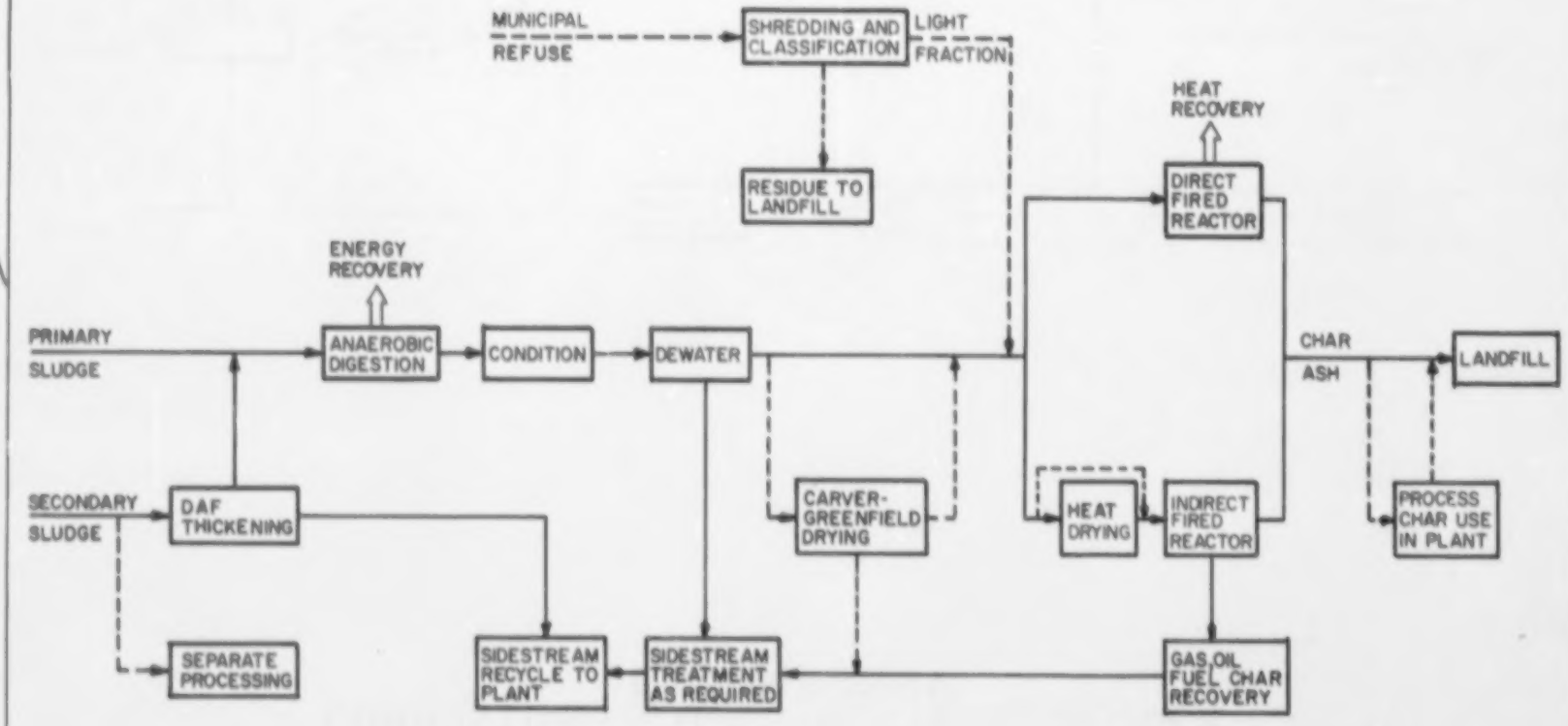
MANAGEMENT ALTERNATIVE 2
COMPOSTING-SLUDGE RECYCLE CENTER
PROCESS DIAGRAM



LA/OMA PROJECT

FIGURE A-3

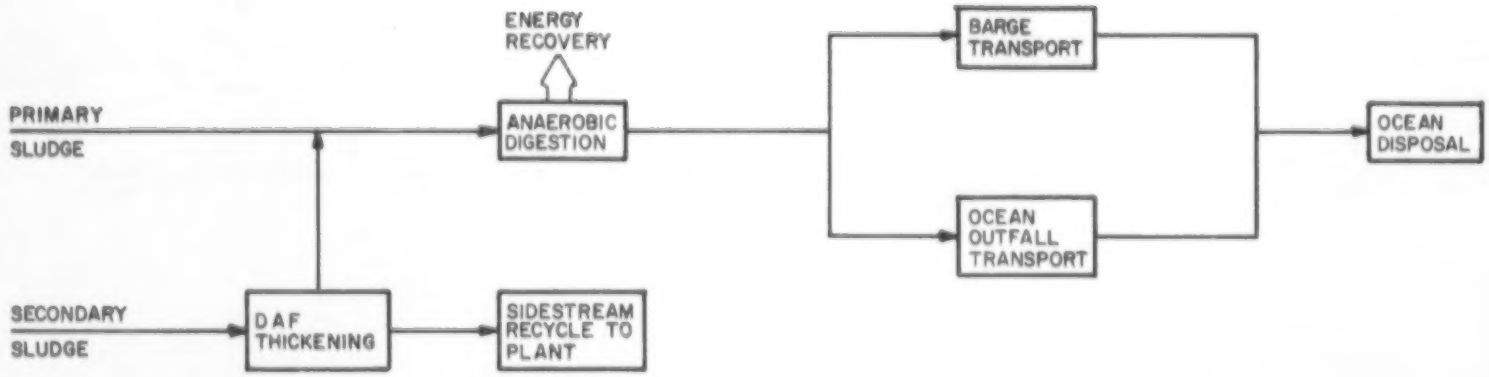
MANAGEMENT ALTERNATIVE 3
THERMAL PROCESSING
PROCESS DIAGRAM



LA/OMA PROJECT

FIGURE A-4

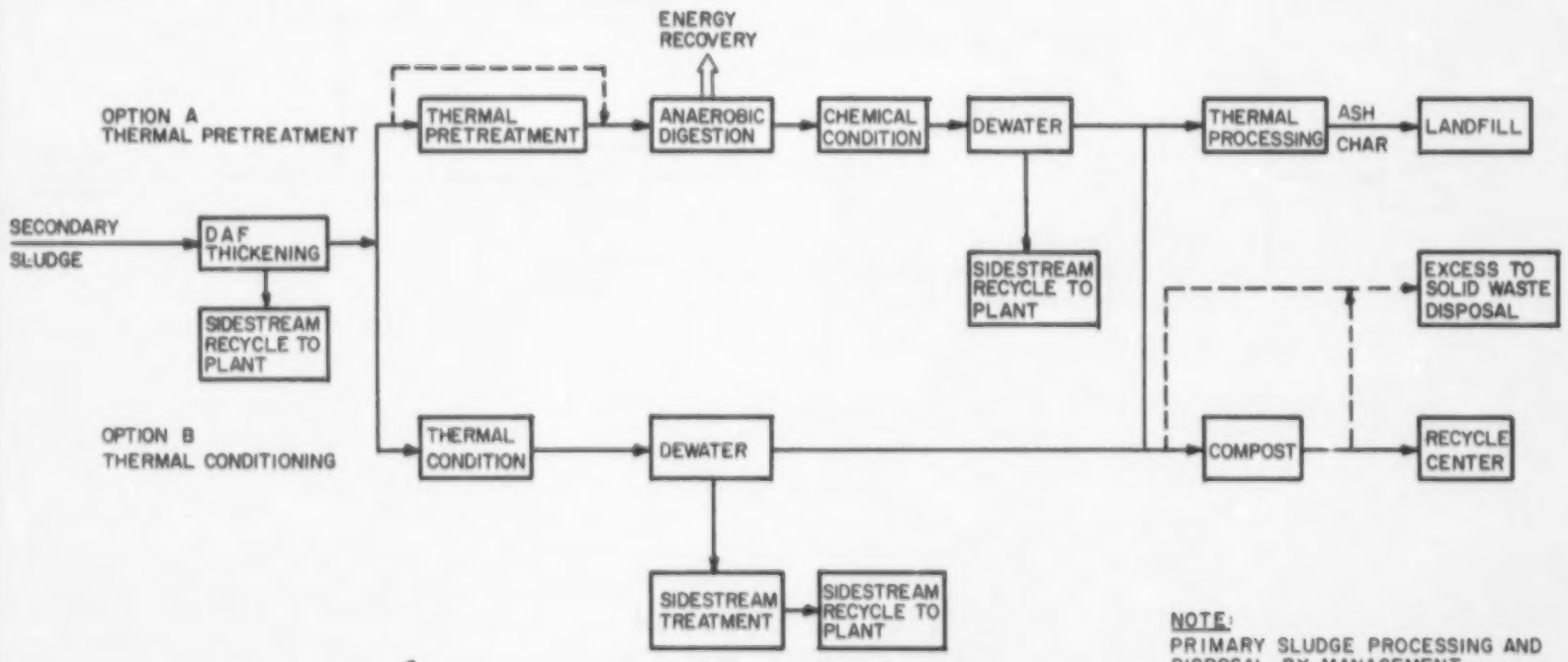
MANAGEMENT ALTERNATIVE 4
OCEAN DISPOSAL
PROCESS DIAGRAM



LA/DMA PROJECT

FIGURE A-5

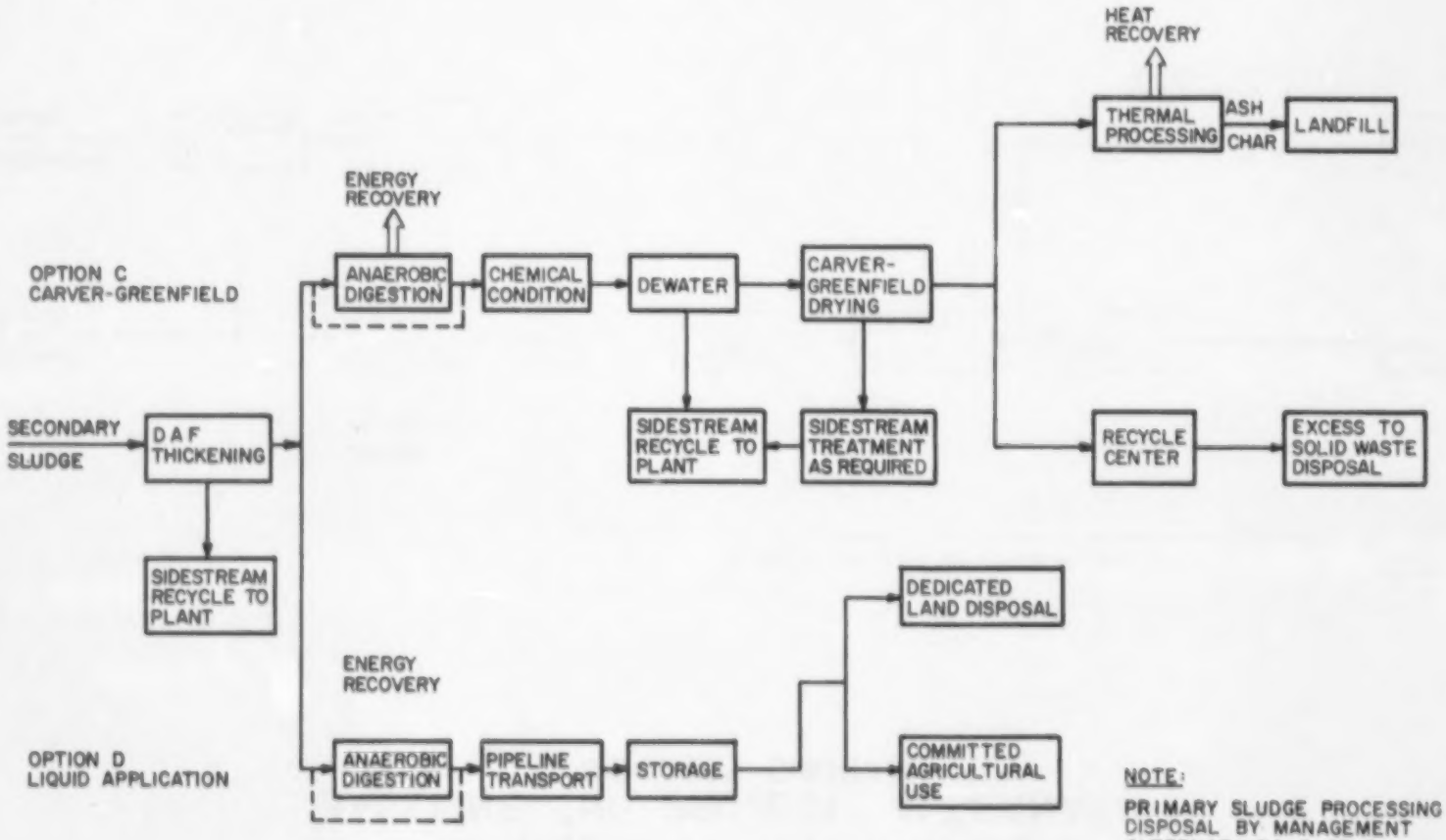
MANAGEMENT ALTERNATIVE 5
SEPARATE SECONDARY SLUDGE PROCESSING
PROCESS DIAGRAM



LA/OMA PROJECT

FIGURE A-6

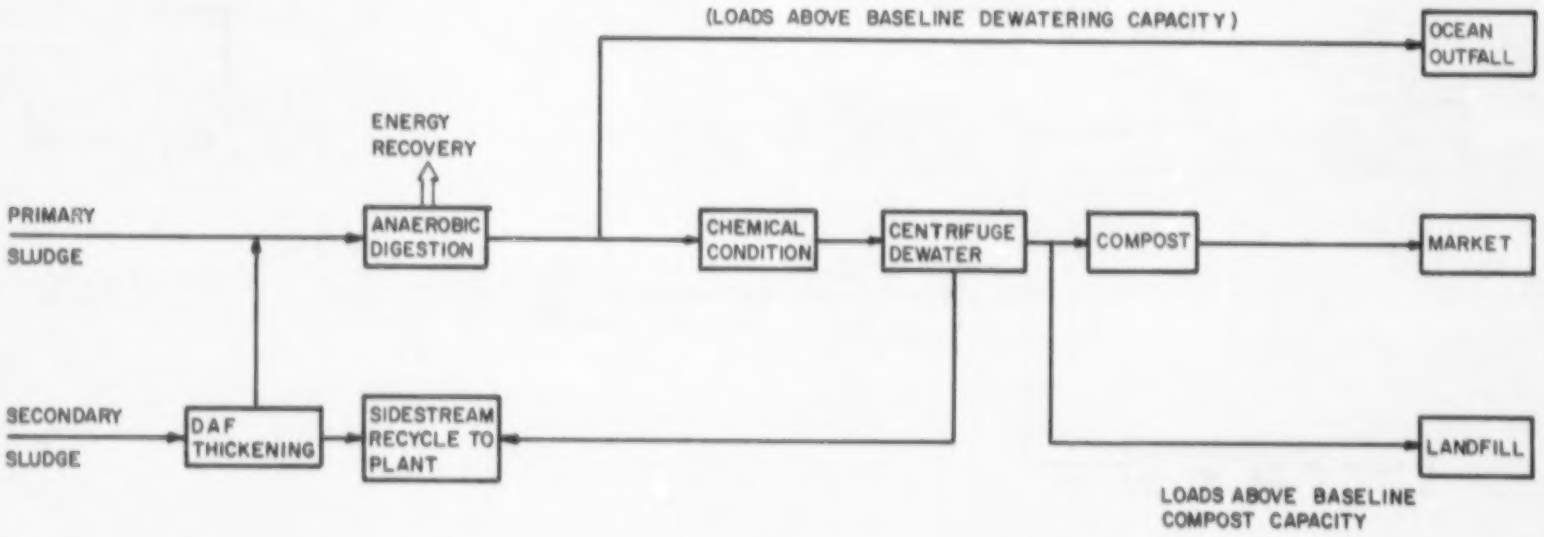
MANAGEMENT ALTERNATIVE 5
SEPARATE SECONDARY SLUDGE PROCESSING
PROCESS DIAGRAM



LA/OMA PROJECT

FIGURE A-7

MANAGEMENT ALTERNATIVE 6
BASELINE "NO PROJECT" ALTERNATIVE
PROCESS DIAGRAM



APPENDIX B

REFERENCES

The following documents have been the primary references upon which this report is based.

1. LA/OMA Project, "LA/OMA Project - Phase I Report" - August, 1976.

2. CH_2M Hill Engineers, "Analysis of Candidate Systems and Preliminary Site Identification", report to LA/OMA Project, April, 1977.

3. LA/OMA Project, "Preliminary Analysis of Ocean Disposal Alternative", Technical Report, April, 1977.

4. LA/OMA Project, "Sludge Processing and Disposal - A State of the Art Review", April, 1977.

• NOTICE •

A series of PUBLIC MEETINGS, to hear YOUR ideas and Comments on sludge processing and disposition is being Scheduled throughout all the COMMUNITIES WHICH MAY BE INVOLVED in the implementation of the SLUDGE MANAGEMENT ALTERNATIVES described in this report.

These PUBLIC MEETINGS will be held in May, June, and July of 1977. For the EXACT TIME and PLACE of the Meeting scheduled for YOUR COMMUNITY .....

LOOK FOR: announcements in the LA/OMA PROJECT NEWS
meeting notices in your local newspaper

WRITE: LA/OMA Project, P.O. Box 4998, Whittier, CA 90607

OR BETTER YET, CALL:

LA/OMA Project, (213)-699-7411, Ext. 235.